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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

RESULTS

OF

PRIMARY TRIANGULATION AND PRIMARY TRAVERSE

FISCAL YEAR 1904-5

BY

SAMUEL S. GANNETT

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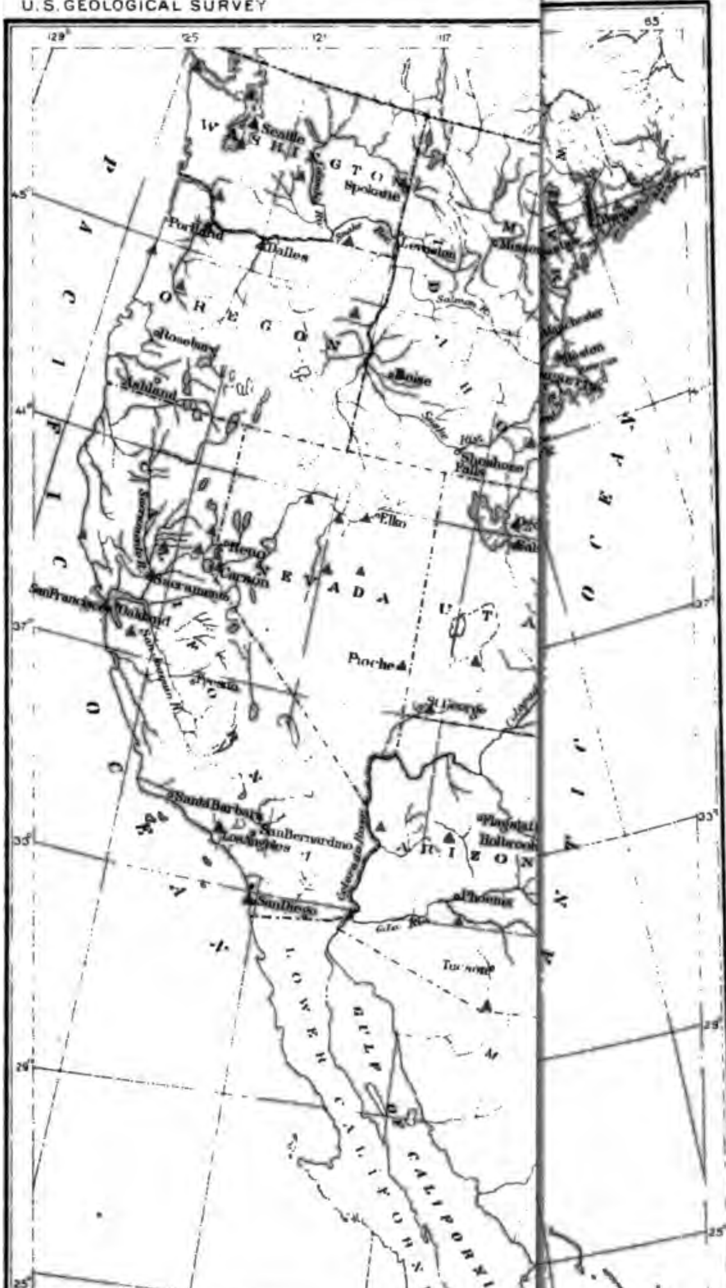
ILLUSTRATION.



MAP SH

Areas tinted are controlled by triangulation or traver

▲ Astronomic station

RESULTS OF PRIMARY TRIANGULATION AND PRIMARY TRAVERSE, FISCAL YEAR 1904-5.

By SAMUEL S. GANNETT.

SUMMARY.

Summary of published results, 1904-5: Triangulation and primary traverse.

Locality.	Triangulation stations.	Traverse stations.
EASTERN DIVISION.		
Alabama	....	183
Georgia	....	139
Illinois	....	212
Iowa	....	145
Kentucky	....	40
Maine	8	....
Maryland	....	170
Minnesota	....	100
Nebraska-Iowa	....	53
New Hampshire-Vermont	11	....
New York	8	179
North Carolina	....	432
Ohio	....	426
Pennsylvania	13	123
South Carolina	....	106
Tennessee	....	170
Wisconsin	....	161
Minnesota-Wisconsin	8	....
WESTERN DIVISION.		
Arizona	15	....
California	25	....
Colorado	49	....
Montana	26	....
Oregon-California	9	....
South Dakota	45	....
Texas	14	....
Wyoming	41	....
Total	272	2,539

EASTERN DIVISION OF TOPOGRAPHY.

H. M. Wilson, *Geographer in charge.*

ALABAMA.

PRIMARY TRAVERSE.

CHILTON AND SHELBY COUNTIES.

BESSEMER 30-MINUTE QUADRANGLE.

The following geographic positions were determined from primary traverse run by Mr. C. B. Kendall in 1904. The line starts from an adjusted position at Generys, follows railroads and wagon roads south, east, and north near the borders of the quadrangle, and is connected with an adjusted position at Leeds. Another line starts from adjusted position at Pelham, follows the Louisville and Nashville Railroad southward near the middle of the quadrangle, and connects with main traverse line along the southern border.

Geographic positions along the Alabama Great Southern Railroad.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Bench mark post No. 173	33 18 18.1	86 54 14.5
Generys, 1.25 miles south of; railway crossing	33 17 46.6	86 55 02.7
Samford, railway crossing	33 16 28.6	86 56 01.3
Trestle No. 217, point over stream	33 15 29.4	86 56 44.8
Turner, railway crossing	33 14 37.6	86 57 28.8
Trestle No. 189, point over stream	33 13 26.2	86 57 39.9
Cahaba River, railroad bridge over, in west end of capstone to south abutment, tablet stamped "Prim. Trav. Sta. No. 41"	33 12 50.2	86 57 36.1
Corner stone marked "16, 17, 20, 21"	33 12 05.7	86 58 09.7
Gurnee Junction, point of switch to west leg of Y	33 11 47.7	86 58 04.6
Gurnee, opposite sign	33 11 20.0	86 58 11.2
Milepost 18, road crossing 300 feet north of	33 10 46.5	86 58 33.5
Anita, road crossing	33 10 27.7	86 58 50.9
Adin, road crossing	33 09 18.8	86 59 52.2
Daly, opposite sign	33 08 45.1	87 00 17.0
Gurnsey, point of frog to Gurnsey branch	33 07 55.8	87 00 29.0
Seymore, road crossing north of	33 06 51.2	87 01 29.4

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Coleanor, southwest corner of store; iron post stamped "Prim. Trav. Sta. No. 100"	33 05 43.7	87 02 11.2
Coleanor, 3 corners 1 mile southeast of; 35 feet north to oak stump	33 05 16.7	87 01 45.3
Small stream, bridge over	33 05 17.9	87 00 38.4
Hill, forks of road near top of, 25 feet north to pine tree, 35 feet south to oak tree	33 05 15.0	86 59 34.1
Four Mile Creek, ford of; 25 feet north to oak tree, 50 feet east to oak tree	33 04 34.1	86 58 12.3
Forks of road south and east, 50 feet southeast to signboard which reads "to Fletchers Bridge," 50 feet north to hickory tree painted "p. t."	33 04 36.2	86 57 46.6
Forks of road north and northwest at milepost "Brierfield 4 miles," 30 feet northeast to pine tree, 20 feet south to hickory	33 03 45.8	86 57 34.0
Brierfield, forks of road 3 miles southwest of; 25 feet southeast to double oak, 65 feet northwest to oak painted "p. t."	33 02 57.7	86 56 47.8
Forks of road south and east at northwest corner of clearing, 70 feet east to locust tree	33 02 09.8	86 58 05.0
Crossroads, 25 feet south to pine, 30 feet northeast to double oak	33 01 58.8	86 58 39.9
Six Mile village, forks of road 0.66 mile northeast of; 40 feet west to oak, 10 feet southeast to sign "C—U 10 mi."	33 00 54.4	86 59 48.5
Six Mile village, south side of east abutment of bridge at; iron post stamped "Prim. Trav. Sta. No. 257"	33 00 26.3	87 00 15.1
Forks of road 10 feet northeast to pine, 30 feet southwest to pine	33 00 31.1	86 58 54.8
Forks of road west and northwest; 30 feet north to clump of oaks; 40 feet south to oak	33 00 49.0	86 57 48.7
Ashby, crossroads 1 mile west of; 25 feet southwest to pine stump, 25 feet northwest to pine stump	33 00 54.8	86 56 38.0
Ashby, railway crossing 400 feet north of station	33 01 12.7	86 55 10.2
Ashby, crossroads 1 mile east of; 30 feet east to bridge, 20 feet west to bridge	33 01 00.8	86 54 22.2
Top of hill, second-class road	33 00 55.5	86 53 22.2
County line, point in road 100 feet north of	33 01 00.3	86 52 52.6
Forks of road west and northwest, 30 feet east to rail fence, painted "P. T."	33 01 05.5	86 52 38.3
Currys ford, 0.25 mile south of; at 3 corners, iron post stamped "Prim. Trav. Sta. No. 349"	33 01 12.4	86 52 08.5
Three corners, 15 feet south to plank fence, 50 feet north to corner of fence, painted "P. T."	33 01 26.6	86 51 02.7
Claring, forks of road at northeast corner of	33 01 27.6	86 49 28.4
Forks of road south and northeast, 100 feet northeast to pine stump, painted "P. T."	33 01 08.2	86 48 29.4
Junction of roads 0.25 mile northeast of Providence Church	33 01 15.5	86 47 49.4
Forks of road; 50 feet east to pine stump, 30 feet west to pine tree	33 01 01.7	86 47 13.0
Ocampo, overhead crossing 1 mile south of	33 01 07.3	86 46 17.4

Geographic positions along Louisville and Nashville Railroad between Pelham and Ocampo.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Pelham, tablet at	33 17 09.8	86 48 52.6
Pelham, road crossing southwest of station	33 17 04.3	86 48 49.5
Keystone, road crossing	33 16 04.0	86 48 46.8
Keystone, road crossing 0.75 mile south of	33 15 36.0	86 48 50.3
Alabaster, road crossing	33 14 37.4	86 49 00.7
Section house, road crossing	33 13 52.5	86 48 52.3
Newela, road crossing	33 13 15.5	86 48 29.9
Saginaw, road crossing	33 13 01.9	86 47 57.5
Road crossing	33 12 21.0	86 46 59.8
Longview station, at southwest corner of company store, iron post stamped "Prim. Trav. Sta. No. 28"	33 11 56.9	86 46 46.0
Longview, second-class road crossing 0.75 mile south of	33 11 24.2	86 46 29.0
Varnons, road crossing	33 09 58.0	86 45 42.3
Dargin, road crossing	33 09 08.6	86 45 29.4
Milepost 425, road crossing 400 feet north of	33 07 59.2	86 45 19.0
Calera, road crossing 1 mile north of	33 07 14.0	86 45 04.7
Calera station, 100 feet north of; 66 feet west of railway, in limestone, aluminum tablet stamped "Prim. Trav. Sta. No. 43"	33 06 13.3	86 45 06.2
Calera, road crossing 0.33 mile south of	33 05 51.4	86 45 05.7
South Calera, on county line, road crossing	33 04 26.4	86 44 58.1
South Calera, 0.75 mile south of, road crossing	33 03 45.6	86 45 11.4
Minooka station	33 02 53.0	86 45 30.5
Minooka, road crossing 0.5 mile south of	33 02 29.3	86 45 38.4
Ocampo station	33 01 54.9	86 45 49.5

JEFFERSON AND SHELBY COUNTIES.

BESSEMER SPECIAL QUADRANGLE.

The following geographic positions on the United States standard datum were obtained from primary traverse run in 1904 by Mr. C. B. Kendall, field assistant. The line starts from a position at Ensley, established by primary traverse in 1904, and follows highways south to Dolomite post-office; thence south along Alabama Great Southern Railroad through Bessemer to McCalla; thence east along highway to Southern Railway at Morgans station; thence south along Southern Railway to Generys station; thence east along highway to Louisville and Nashville Railroad at Fallston station, thence north and east along Louisville and Nashville Railroad through Helena to Pelham; thence northeast along highways through Highland to Quito; and thence north along highways to Birmingham, closing on position established by primary traverse in 1904.

Geographic positions along highways between Ensley and Dolomite.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Ensley and Pratt City stations, between, cemented in masonry pedestal of iron bridge over village creek, bronze tablet "No. 8"	33 31 14.8	86 53 21.4
Ensley, center of 17th street and F avenue	33 30 49.7	86 53 40.9
Oakland Church, road junction at, 35 feet northwest to oak tree, 50 feet northeast to corner of church	33 29 43.0	86 54 05.2
Forks of road, 40 feet east to oak tree, 30 feet northwest to lot fence	33 28 43.1	86 55 29.9
Center of Louisville and Nashville Railroad at public road crossing, 300 feet east of church and cemetery	33 27 27.3	86 57 05.7
Dolomite, center of track at Woodwards Railroad at road crossing, 0.25 mile south of	33 27 25.8	86 57 38.8

Geographic positions along the Alabama Great Southern Railroad between Dolomite and McCalla.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Junction of Woodwards Coal and Iron Company's Railroad and Louisville and Nashville Railroad, center of tracks at	33 26 38.5	86 57 55.6
Frisco Railroad at trestle over small creek	33 25 51.3	86 58 13.9
Public road crossing, center of Frisco Railroad, main track	33 25 04.4	86 58 05.1
Crossing of Frisco Railroad and B. & B. Electric Railway, center of tracks	33 24 37.2	86 57 48.6
Bessemer, east end of Louisville and Nashville Railroad station at	33 24 13.4	86 57 09.3
Bessemer, in top doorstep in south side of east entrance to city hall, aluminum tablet stamped "Prim. Trav. Sta. No. 59"	33 24 04.4	86 57 16.9
Jonesboro, street crossing 600 feet north of water tank	33 23 21.8	86 57 34.1
Trestle at point over creek	33 22 39.2	86 58 08.6
Junction of Southern Railroad and Alabama Great Southern Railroad, point of switch opposite operator's office	33 22 08.0	86 58 33.7
McCalla station, road crossing 0.5 mile east of	33 20 31.7	87 00 00.8
McCalla station, public road crossing in center of track of Alabama Great Southern Railroad	33 20 02.9	87 00 30.4
McCalla station, 135 feet south of center of Alabama Great Southern tracks, on west edge of road to Helena, in top of limestone bowlder, bronze tablet	33 20 02.1	87 00 29.1

Geographic positions along highways between McCalla and Morgan.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Pleasant Hill schoolhouse and church, 4 corners 400 feet west of; 35 feet northeast to milepost, 40 feet east to stump	33 19 49.2	86 59 56.3
Clear Branch Gap, 4 corners 0.5 mile east of, 20 feet northwest to signpost, 30 feet southeast to corner yard fence	33 19 46.4	86 58 56.1
Forks of road west and north, 15 feet northeast to old pine stump, 20 feet south to small gum tree	33 19 51.7	86 57 42.9
Bynems ford, center of Shade Creek	33 19 32.1	86 56 55.0
Forks of road at Dry Creek bed	33 19 37.5	86 56 07.2
Public road, center of Southern Railroad trestle over	33 20 09.6	86 55 22.1
Morgan station, road crossing 0.5 mile south of	33 19 36.4	86 54 36.2

Geographic positions along Southern Railway near Generys station.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Public road crossing, center of track at trestle over	33 18 55.3	86 54 14.8
Generys station, 15 feet east of center of Southern Railroad track, at road crossing at south end of small cut 0.25 mile south of station, iron post stamped "Prim. Trav. Sta. No. 173=0"	33 18 18.1	86 54 14.5
Three corners, mound of earth at	33 17 29.6	86 53 46.7
Cahaba River, forks of road just west of bridge over	33 17 07.8	86 53 16.1
Fallston station, road crossing at center of track of B. & B. Branch L. & N. R. R	33 17 19.8	86 51 38.2

Geographic positions along the Louisville and Nashville Railroad between Fallston and Pelham.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Helena, center of Louisville and Nashville main line, opposite agent's office, station	33 17 45.3	86 50 38.9
Helena, road crossing 0.75 mile south of	33 17 47.1	86 50 00.5
Pelham, in limestone bowlder at forks of road, 60 feet east of Louisville and Nashville Railroad main line track at road crossing, and 500 feet north of station, aluminum tablet	33 17 09.8	86 48 52.5
Pelham, forks of road 1 mile northeast of	33 18 02.7	86 48 40.7

Geographic positions along highways between Pelham and Birmingham.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Forks of road	33 18 38.5	86 48 17.1
Denson Creek, 3 corners 200 feet east of ford	33 19 46.3	86 47 30.6
Highland Church, center of road opposite	33 20 28.7	86 46 23.8
Three corners, 30 feet northeast to plank fence, 40 feet west to persimmon tree at fence corner	33 20 55.6	86 45 33.5
Forks of road, 20 feet north to oak tree, 50 feet east to large rock	33 21 17.6	86 44 44.8
Church, forks of road 300 feet west of ford of Denson Creek, 30 feet west to long stone, 35 feet south to oak tree	33 21 38.8	86 44 07.0
Allen's gin, forks of road 0.25 mile east of; 45 feet north to oak tree, 30 feet southwest to milepost	33 22 22.6	86 42 26.8
Forks of road, large oak tree	33 22 18.0	86 43 21.3
Bailey's gap, highest point in center of road	33 22 42.7	86 44 03.7
Forks of road, 15 feet southwest to corner of rail fence, 10 feet east to corner rail fence	33 23 01.0	86 44 19.1
Forks of road, near top of hill, 15 feet east to flat rock in east fork	33 23 37.5	86 44 12.7
Forks of road, 40 feet east to oak tree	33 24 03.4	86 44 24.4
Caldwells ford, forks of road near signboard, 500 feet north of north part of Cahaba River, iron post stamped "Prim. Trav. Sta. No. 433"	33 24 58.7	86 44 23.0
Forks of road; 15 feet west to rail fence, 20 feet east to rail fence	33 25 36.1	86 44 08.2
Little Valley Mountain, forks of road 0.25 mile south of top of, 40 feet north to pine tree	33 26 17.8	86 44 49.7
Forks of road, 25 feet southeast to signboard	33 27 23.3	86 45 15.3
Cahaba reservoir, 3 corners at, 20 feet east to signboard	33 27 50.6	86 45 26.6
Shade Creek, 3 corners 300 feet north of	33 28 30.5	86 45 51.4
Birmingham, 4 corners 3 miles south of; 10 feet northwest to signpost "Okmoor 6 mi.", 15 feet east to signpost "Irondale 6 mi."	33 29 00.0	86 46 25.5
Hedena station, center of main track of Birmingham South Mineral Railroad	33 29 44.0	86 46 54.0
Birmingham, center of 24th street and avenue B	33 30 47.7	86 47 52.8
Birmingham, center of 26th street and 8th avenue	33 31 30.8	86 48 08.7

GEORGIA.

PRIMARY TRAVERSE.

LUMPKIN COUNTY.

DAHLONEGA SPECIAL QUADRANGLE.

Geographic positions from primary traverse by Mr. E. L. McNair, topographer, in 1905. The line starts from the tower on Dahlonega Agricultural College located by triangulation of the Coast and Geo-

detic Survey; follows highways north to border of quadrangle; thence west, south, and east to a point nearly south of Dahlonega; thence north to starting point. Beginning again on south border of quadrangle the line runs east, north, and west connecting with point where the original line touched the border of quadrangle, thus making two complete circuits. Positions are given on United States standard datum.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Dahlonega Agricultural College, center of tower	34 31 47.95	83 59 13.25
Forks of road	34 32 28.6	83 59 27.6
Forks of road	34 33 27.2	83 59 51.9
Forks of road	34 34 00.7	84 00 28.1
W. H. Wimpy, opposite front gate of	34 34 48.5	84 01 18.5
J. K. Lance, southeast corner of porch of	34 34 35.2	84 01 36.3
Ridge, forks on west side and near top of	34 34 36.1	84 02 16.7
Old mill dam, crossing of brook	34 34 41.9	84 03 30.3
Milepost, reads "Dahlonega 7"	34 33 52.0	84 03 27.8
Henry Johnsons, crossroads at	34 33 25.0	84 03 28.6
Forks of road, signboard reads "Coopers 15 miles, Dahlonega 6 miles"	34 32 39.2	84 03 23.8
Siloam Church, 4 corners	34 31 47.0	83 02 29.6
Forks of roads	34 30 06.6	84 02 38.6
Auraria, junction of roads 1 mile north of	34 29 14.4	84 01 14.8
Chestatee River, bridge over, east end of	34 28 53.9	83 59 40.1
F. S. Packard's house, top of hill 200 feet west of	34 29 14.8	83 58 57.7
Middle road from Dahlonega to Gainesville, junction with	34 29 17.5	83 58 16.6
Hull's mill, west end of bridge over Chestatee River	34 30 06.3	83 58 09.4
Crown Mountain mill, top of hill 0.33 mile south of	34 31 22.0	83 58 34.7
M. M. Loudin's house, opposite, on Long Branch	34 28 15.1	83 57 54.5
Forks of road (settlement road to north)	34 28 14.6	83 57 14.0
Forks of road at top of hill	34 28 02.3	83 56 40.3
St. Pauls Church, 4 corners	34 27 01.7	83 56 11.1
Forks of road, signboard reads "Gainesville 15 miles"	34 27 53.3	83 55 30.3
Forks of road at house of Mr. Griswold	34 28 47.2	83 55 10.5
Forks of road, signboard reads "Newbridge 7 miles"	34 29 50.1	83 54 48.0
Garland, northwest corner Bowen's store	34 30 57.1	83 54 32.7
Garland, forks of road 1 mile northwest of	34 31 33.1	83 55 14.4
Power plant of Crown Mountain Co., end of crib and rock work, on south side of river	34 32 09.5	83 55 37.4
Anderson's store, forks of road 400 feet west of	34 33 20.8	83 55 46.5
Forks of road, signboard reads "Cleveland 9 miles, Blairsville 29 miles"	34 33 43.8	83 54 20.6
Forks of road to Jumbo mine	34 34 30.0	83 54 23.0

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Forks of road, 3 notches cut in oak tree	34 34 47.2	83 55 10.3
Forks of road, signboard reads "Dahlonega 5.5 miles"	34 34 57.4	83 55 49.9
Anderson (Allen), house of, 300 feet west of cloth penalty notice on persimmon tree	34 34 35.2	83 56 33.6
Junction with public road	34 34 46.2	83 57 21.5
Church, forks of road	34 34 21.9	83 58 03.6
Anderson (Floyd), house of, in front of	34 34 57.5	83 58 48.2
Ridge, top of	34 35 02.9	83 59 50.8
Junction of roads, cloth penalty notice on oak tree	34 35 00.9	84 00 21.2

HARRIS, MERIWETHER, MUSCOGEE, AND TALBOT COUNTIES.

TALBOTTON QUADRANGLE.

The following geographic positions were obtained by primary traverse run in 1905 by Mr. E. L. McNair, topographer. The line starts at Columbus from an adjusted position established by Mr. J. R. Ellis in 1902, and follows the Central of Georgia Railway east to Paschal; thence north over the Talbotton Railroad to Talbotton; thence north over highways to Belleview; thence west over highways through Cleola and Hamilton to Westpoint, connecting with an adjusted position at that place.

Another line runs from Belleview north over highways to Woodbury; thence west along the Macon and Birmingham Railway to Harris, and is tied to a traverse position at that place.

Geographic positions along the Central of Georgia Railway between Columbus and Paschal.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Columbus, crossing of First avenue and Central of Georgia Railway	32 28 39.1	84 59 29.8
Columbus, north end of train shed, Central of Georgia Railway station	32 28 09.5	84 59 02.8
Willett, 16 feet north of C. of G. R. R. track, and 10 feet west of crossing sign at road crossing, U. S. Geological Survey bench-mark post; stamped "1905 Prim. Trav. Sta. 1"	32 27 11.9	84 57 46.8
Road crossing	32 27 19.3	84 56 43.5
Milepost 96	32 28 05.7	84 56 02.6
Road crossing	32 29 10.0	84 54 34.0
Road crossing, 2d class	32 30 01.2	84 53 44.4
Schatulga station, road crossing	32 30 58.5	84 52 06.0
Road crossing	32 31 40.6	84 51 16.6
Milepost 90, 30 feet north of center of track and 1,100 east of; iron post stamped "1905 Sta. 2, Prim. Trav."	32 31 40.9	84 51 16.8

Geographic positions along the Central of Georgia Railway, etc.—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Road crossing	32 32 17.9	84 50 25.4
Road crossing	32 32 43.0	84 48 40.9
Road crossing	32 32 59.7	84 46 41.9
Upatoie station, directly in front of C. of G. R. R. station, iron post stamped "1905 Prim. Trav. Sta. 3"	32 32 49.6	84 44 25.1
Road crossing	32 32 26.9	84 43 15.0
Road crossing	32 32 12.3	84 42 01.9
Road crossing	32 32 06.8	84 40 17.9
Boxspring station, center of main track opposite	32 31 56.1	84 39 36.7
Milepost 76	32 32 23.0	84 38 04.7
Juniper station at west end of R. R. station, 25 feet south of track center, iron post stamped "1905 Prim. Trav. Sta. 4"	32 32 55.2	84 36 11.6
Milepost 73	32 33 27.2	84 35 16.9
Road crossing	32 34 02.8	84 34 15.2
Geneva station	32 34 43.2	84 33 05.1
Road crossing	32 34 35.5	84 32 08.8
Road crossing	32 35 04.5	84 30 34.2
Milepost 66	32 36 05.9	84 29 12.2
Paschal station, road crossing	32 36 31.4	84 28 13.4
Paschal station, 86 feet east of R. R. station, iron post stamped "1905 Prim. Trav. Sta. No. 5"	32 36 31.6	84 28 12.9

Geographic positions along the Talbotton Railway between Paschal and Talbotton.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Road crossing	32 37 03.0	84 28 20.7
Road crossing	32 37 52.0	84 28 40.9
Smithboro station, road crossing	32 38 31.3	84 29 57.7
Road crossing	32 39 49.4	84 31 03.3
Talbotton, street crossing at station	32 40 35.5	84 32 11.4
Talbotton, 15 feet south of main front entrance to Talbott County court-house, iron post stamped "1905 Prim. Trav. Sta. 6"	32 40 36.8	84 32 25.2

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Forks of road	32 42 18.1	84 32 30.7
Four corners at house of W. S. Couch	32 43 37.7	84 33 07.1
Lazer Creek, south end of covered bridge over	32 44 31.7	84 33 16.4

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Road west, at house of Pete Mahone	32 45 47.6	84 33 28.7
J. H. Bryan's house, inside of yard, 24 feet north of front gate and 33 feet from northeast corner of house, iron post stamped "1905 Prim. Trav. Sta. 7"	32 46 07.0	84 33 28.3
Center of road opposite house of J. W. Jones	32 45 01.5	84 34 35.8
Four corners	32 44 37.3	84 35 58.7
Kellam place, opposite large white house	32 43 54.4	84 37 06.4
Matthews Chapel, road southwest	32 43 34.8	84 37 35.0
G. M. Allen, opposite new house of	32 44 15.8	84 38 23.3
Top of hill, where three roads meet	32 44 47.1	84 39 01.2
Joel Walker's house, road north, south, and west	32 44 18.9	84 40 32.6
Cleola post-office, 4 corners, 1¼ miles east of	32 44 30.7	84 42 15.0
Oak Mountain station, 55 feet west of Southern Railway track and 78 feet from southwest corner of station, iron post stamped "1905 Prim. Trav. Sta. 11"	32 44 32.0	84 43 31.6
A. G. Miller, opposite house of	32 44 22.2	84 44 01.6
Cleola post-office, forks of road 2½ miles west of and 200 feet east of 4 corners	32 43 50.2	84 45 37.0
North end of covered bridge	32 44 41.0	84 46 23.1
Forks of road at top of hill near old church	32 44 25.0	84 47 32.3
Four corners	32 43 49.4	84 48 42.6
Four corners	32 44 02.8	84 50 10.5
Hamilton station, forks of road, 1¼ miles south of	32 44 33.5	84 52 10.7
Hamilton, in front of Robinson's hotel and 130 feet north of court-house, iron post stamped "1905 Prim. Trav. Sta. 12"	32 45 30.0	84 52 30.3
Hamilton station	32 45 37.3	84 52 37.0

This line starts from Hamilton, Ga., a position determined by Mr. J. R. Ellis in 1902, and follows highways through Whitesville to West Point, connecting with a primary traverse position there.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Hamilton, station, Central of Georgia Railway	32 45 37.3	84 52 37.0
Forks of road at foot of mountain	32 46 38.0	84 53 27.4
Forks of road	32 46 39.9	84 54 03.7
W. L. Harris, center of road opposite house of	32 46 45.8	84 55 15.1
Schoolhouse, roads east, west, and south	32 46 50.0	84 57 19.2
Forks of road	32 47 35.1	84 57 50.5
Ira Davis, forks of road at house of	32 47 33.5	84 58 44.5
T. W. Haralson, opposite house of	32 48 23.9	84 56 43.8

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Four corners, about 250 feet west of house of W. M. Maddox	32 48 45.7	85 00 24.0
Whitesville, near intersection of roads on south side, 30 feet west of corner of Tyler's store, iron post stamped "Prim. Trav. Sta. 13"	32 49 04.1	85 01 58.7
Forks of road	32 49 50.7	85 03 01.2
J. F. Sands, forks of road at house of	32 50 19.5	85 03 56.1
Forks of road, 110 feet west of G. A. Myhand's house	32 50 43.9	85 06 01.3
Pearson's mills, center of Shoal Creek, between piers of new bridge	32 50 20.1	85 07 00.3
J. H. Hawkins, opposite tenement house of	32 51 14.9	85 07 54.7
Long Cane Creek crossing	32 51 57.1	85 09 34.9
West Point, soldiers' monument	32 52 31.7	85 10 40.7
West Point, station, Western Railway of Alabama	32 52 31.8	85 11 01.6

Line from Belleview north over highways through Chalybeate to Woodbury, thence west over Macon and Birmingham Railway to Harris.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Road southeast	32 46 33.5	84 32 08.3
Road south	32 47 20.2	84 30 36.8
Pleasant Hill, forks of road	32 48 07.4	84 30 00.9
Forks of road	32 49 20.1	84 30 47.9
Road south	32 49 31.1	84 31 39.7
Chuck's store, forks of road	32 49 48.4	84 32 10.7
Forks of road	32 51 26.5	84 32 46.7
Road north	32 51 44.6	84 33 14.6
Chalybeate, in grove of trees just east of road and 262 feet from northwest corner of Nelson's store, iron post stamped "Prim. Trav. Sta. No. 8"	32 51 31.4	84 34 47.3
Forks of road, near Mrs. Doctor Campbell's house	32 51 58.1	84 36 10.8
Four corners	32 53 05.4	84 35 53.3
Four corners, at W. B. Johnson's mail box	32 54 03.7	84 35 58.5
Road west	32 55 46.1	84 36 10.8
W. P. Gill, forks of road at house of	32 56 17.6	84 36 07.9
W. J. Wells, forks of road at house of	32 56 51.1	84 35 07.0
Cane Creek crossing, long bridge over	32 57 33.1	84 35 45.2
Woodbury station, 0.33 mile west of, 800 feet west of Macon and Birmingham and Southern Railway, and 50 feet southwest of road crossing, on bank 8 feet above track, iron post stamped "Prim. Trav. Sta. No. 9"	32 58 36.1	84 35 13.2

Geographic positions along the Macon and Birmingham Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Road crossing	32 58 46.6	84 36 46.1
Road crossing	32 58 41.4	84 38 20.3
Negro schoolhouse, road crossing at	32 58 37.0	84 39 05.4
Road crossing	32 58 14.6	84 40 46.3
Road crossing	32 58 01.4	84 41 26.2
Harris, 63½ feet from crossing of Macon and Birmingham Railway and Central of Georgia Railway, iron post stamped "Prim. Trav. Sta. No. 10"	32 58 05.7	84 42 48.2
Harris, crossing of Macon and Birmingham Railway and Central of Georgia Railway	32 58 05.7	84 42 47.5

ILLINOIS.

PRIMARY TRAVERSE.

MADISON AND ST. CLAIR COUNTIES.

BELLEVILLE QUADRANGLE.

The following geographic positions on the United States standard datum were determined by primary traverse in 1905 by Mr. J. R. Ellis, assistant topographer. The line starts from United States Coast and Geodetic Survey triangulation station, Sugarloaf, follows highways south to Belleville; thence east along the Southern Railway to east edge of quadrangle; thence along highways north to northeast corner of quadrangle, connecting with Berger triangulation station and Parkinson triangulation station; thence west along highways to northwest corner of quadrangle, and south to Sugarloaf triangulation station.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Sugarloaf triangulation station: Near middle of north line of NE. ¼, sec. 20, T. 3 N., R. 8 W., on bluff overlooking American Bottom, 3 miles northwest of Collinsville on land of C. Witte, on top of prominent mound, which is 50 feet above the ground to the east and 150 to 200 feet above American Bottom on west. Station mark: A marble post 6 by 6 inches by 2½ feet long, top 1 inch above ground and marked thus: U. S. / C. & G. S.	38 42 05.3	90 00 27.5
Center of iron bridge near road corner	38 41 17.5	90 00 28.0
Collinsville crossing of Combs avenue and Clay street	38 40 05.9	89 59 41.0
Collinsville and Belleville road crossing Pennsylvania Railroad at electric power house	38 39 39.5	89 58 56.4

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Collinsville, 3 miles southeast of; in southwest corner of stone foundation of Bethel Church, aluminum tablet stamped "Prim. Trav. Sta. No. 14, 1905"	° ′ ″ 38 38 41.1	° ′ ″ 89 57 42.1
T. 2 N., R. 8 W., secs. 10, 11, 14, and 15, road crossing near corner	38 37 17.9	89 57 58.3
T. 2 N., R. 8 W., quarter corner between secs. 22 and 23, T road east	38 36 20.8	89 57 58.2
Ridge Prairie saloon, crossroads at	38 35 33.4	89 57 58.1
Hy Pfeifer's saloon and hotel, 1 mile south of road west	38 34 23.8	89 57 57.7
T road west at schoolhouse	38 33 35.9	89 57 56.2
Road crossing, O'Fallon branch Louisville and Nashville Railroad, 100 feet north of milepost 18	38 32 26.6	89 57 52.0
Belleville, street crossing Louisville and Nashville Railroad, main line	38 31 48.6	89 59 00.9
Belleville, in northeast corner of court-house yard, iron post stamped "Prim. Trav. Sta. No. 15, 1905"	38 30 47.3	89 58 50.3

Geographic positions along Southern Railway from Belleville eastward.

Station.	Latitude.	Longitude.
Belleville, crossing of Southern Railway under Louisville and Nashville Railroad, near city reservoir	° ′ ″ 38 31 35.6	° ′ ″ 89 58 50.3
Mines, road crossing north and south	38 32 01.6	89 57 50.0
Road crossing north and south	38 32 00.9	89 56 49.3
T. 1 N., R. 8 W., quarter corner between secs. 13 and 14	38 32 01.4	89 56 49.3
Road crossing, north and south, 760 feet east of telegraph office	38 32 02.3	89 55 43.4
Shiloh station, milepost 22, road crossing north and south	38 32 02.8	89 53 55.7
Road crossing north and south between mileposts 23 and 24	38 32 00.7	89 52 07.6
Grassland on property of Chas. Griffin, northeast corner of post-office, bears S. 85° 40′ W., distant 110 feet, iron post stamped "Prim. Trav. Sta. No. 16, 1905"	38 31 57.1	89 50 19.1
Road crossing north and south, 150 feet west of milepost 27	38 31 58.1	89 48 25.0
Road crossing north and south, 170 feet west of milepost 28	38 31 57.1	89 47 18.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
North and south road crossing of Southern Railway, near southwest corner of field of J. B. Freese, iron post stamped "Prim. Trav. Sta. No. 17, 1905"	° ′ ″ 38 31 55.6	° ′ ″ 89 45 38.9
T. 1 N., R. 6 W., near quarter corner between secs. 3 and 10, crossroads	38 33 13.8	89 45 06.6

Geographic positions along highways.—Continued.

<table>
<tr><th>Station.</th><th>Latitude.</th><th>Longitude.</th></tr>
<tr><td></td><td>° ′ ″</td><td>° ′ ″</td></tr>
<tr><td>Truss Bridge</td><td>38 34 04.0</td><td>89 45 07.6</td></tr>
<tr><td>T. 2 N., R. 6 W., quarter corner between secs. 27 and 34, crossroads</td><td>38 34 57.5</td><td>89 45 07.2</td></tr>
<tr><td>Summerfield, in water table at southeast corner of public school building, aluminum tablet stamped "Prim. Trav. Sta. No. 18, 1905"</td><td>38 35 56.3</td><td>89 45 09.8</td></tr>
<tr><td>Berger triangulation station, near northwest corner of NE. ¼ of NW. ¼ sec. 22, T. 2 N., R. 6 W., on property of Doctor Berger, 1 mile north of Summerfield and 3 miles east and ½ mile north of village of Lebanon. Station mark: An earthenware pyramid marked "U. S. C. S.," 36 inches below surface, above which is a marble post 30 inches long and 6 inches square, marked
<table><tr><td>U.</td><td>S.</td></tr><tr><td>C. & G.</td><td>S.</td></tr></table>its upper surface even with ground.
Western reference mark is a marble post 32 inches long, 4 inches square, in range with eastern row of trees in Doctor Berger's orchard; it is, as nearly as could be determined, on north boundary of sec. 22, which is boundary of Berger's land. Position of western reference mark</td><td>38 36 42.4</td><td>89 45 32.1</td></tr>
<tr><td>T. 2 N., R. 6 W., crossroads at 100 feet north to small bridge center</td><td>38 37 34.4</td><td>89 45 06.6</td></tr>
<tr><td>Crossroads 40 feet southwest to mail box, 36 feet northwest to culvert</td><td>38 38 13.8</td><td>89 45 09.1</td></tr>
<tr><td>Ts. 2 and 3 N., R. 6 W., quarter corner between secs. 3 and 34, crossroads at; also line between Madison and St. Clair counties</td><td>38 39 18.8</td><td>89 45 11.4</td></tr>
<tr><td>T. 3 N., R. 6 W., quarter corner between secs. 22 and 27, T road south</td><td>38 41 04.3</td><td>89 45 13.3</td></tr>
<tr><td>T road east, 160 feet south of iron bridge</td><td>38 41 57.5</td><td>89 45 47.8</td></tr>
<tr><td>St. Jacobs, crossroads at Nollbaner's hotel, in south part of.</td><td>38 42 50.8</td><td>89 46 05.6</td></tr>
<tr><td>Crossroads at quarter corner between secs. 11 and 14</td><td>38 42 49.5</td><td>89 44 08.4</td></tr>
<tr><td>Crossroads at quarter corner between secs. 12 and 13</td><td>38 42 47.9</td><td>89 43 01.6</td></tr>
<tr><td>Parkinson triangulation station: On land of M. A. Parkinson, in middle of NE. ¼ sec. 12, T. 3 N., R. 6 W., and 1.5 miles west by south from Highland. Station mark: The vertex of a hollow square earthenware pyramid 3 feet below surface, with letters "U. S. C. S." cut on its sides, over which is a marble post 6 by 6 inches and 2.25 feet long, on top of which letters "U. S. C. & G. S." are cut. Reference marks: Two marble posts 5 inches square, 2.5 feet long, 2 inches above ground with a line diagonally across tops terminating in arrowhead, arrowhead pointing to station; northeast reference mark 18 feet 8¾ inches to station center; southeast mark 18 feet 8⅛ inches to station center; from center of northeast mark to southeast mark, 25 feet 8 inches; from station center to surveyors rock, 16 feet 9½ inches</td><td>38 43 26.9</td><td>89 42 44.3</td></tr>
</table>

Geographic positions along highways.—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Highland, about 2 miles west of; road crossing north and south, 480 feet east of water tank	38 44 02.9	89 42 48.3
In southwest corner of wood pasture owned by John Regel, iron post stamped "Prim. Trav. Sta. No. 19," corner stone in center of road bears S. 2° W., distant 17 feet	38 44 32.5	89 44 24.2
T road north, 16 feet northeast to cross on fence post, 19 feet northwest to west end of culvert	38 44 32.9	89 45 47.1
T road west at Marine cemetery	38 44 59.7	89 46 54.4
T road east 1.5 miles west of Marine cemetery	38 45 00.7	89 48 34.2
Silver Creek, national road over west fork of, center of iron bridge on	38 45 18.6	89 49 18.4
Troy, 5.2 miles northeast of; in northwest corner of pasture owned by Henry Wendler, at forks of road, iron post stamped "Prim. Trav. Sta. No. 20, 1905"	38 44 46.3	89 51 02.1
T. 4 N., R. 7 W., corner secs. 27, 28, 33, and 34, T road south	38 45 32.3	89 52 27.7
T. 4 N., R. 7 W., corner secs. 28, 29, 32, and 33, stone	38 45 32.1	89 53 35.1
T road west, 12 feet southeast to stone in north and south road	38 45 59.0	89 54 43.2

Geographic positions along the Illinois Central Railroad between Mont and Peters.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Mont, Illinois Central Railroad station	38 46 02.1	89 55 50.0
Suburban electric railroad crossing over Illinois Central Railroad	38 45 40.1	89 57 23.4
Glen Carbon, near Illinois Central Railroad station, on property of Madison Coal Co., southeast of Illinois Central Railroad station, iron post stamped "Prim. Trav. Sta. No. 21, 1905"	38 44 45.4	89 58 59.8
Peters station, road crossing north and south	38 44 30.9	90 00 07.3

CHAMPAIGN AND PIATT COUNTIES.

MAHOMET QUADRANGLE.

The following geographic positions were obtained by primary traverse run by Mr. J. R. Ellis in 1905. The line starts from a position near Thomsonboro located by primary traverse, follows highways west, south, and east near borders of quadrangle, and is connected with an adjusted traverse position near Tolono. Positions are given on United States standard datum.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 21 N., R. 9 E., corner secs. 29, 30, 31, and 32, at crossroads	40 14 19.3	88 12 45.5
T. 21 N., R. 9 E., northeast corner sec. 36, iron post stamped "Prim. Trav. Sta. No. 8 1905"	40 14 18.5	88 13 54.8
T. 21 N., R. 9 E., corner secs. 25, 26, 35, and 36, at crossroads	40 14 18.5	88 15 03.4
T. 21 N., R. 8 E., corner secs. 26, 27, 34, and 35, T road east	40 14 18.0	88 16 12.2
T. 21 N., R. 8 E., quarter corner between secs. 27 and 28, crossroads	40 14 44.2	88 17 21.2
T. 21 N., R. 8 E., quarter corner between secs. 28 and 29, crossroads	40 14 43.8	88 18 29.5
T. 21 N., R. 8 E., quarter corner between secs. 29 and 30, crossroads	40 14 43.5	88 19 39.0
T. 21 N., Rs. 7 and 8 E., quarter corner between secs. 25 and 30, T road east	40 14 43.7	88 20 47.2
T. 21 N., R. 7 E., quarter corner between secs. 25 and 26, T road east	40 14 43.0	88 21 54.0
T. 21 N., R. 7 E., in northeast corner sec. 35, stone to corner secs. 25, 26, 35, and 36 bears N. 41° 50′ E., distant 38 feet. Nail in blaze on east side of hickory tree bears S. 39° 20′ W., distant 29.4 feet. Iron post stamped "Prim. Trav. Sta. No. 9 1905"	40 14 16.4	88 21 54.2
T. 21 N., R. 7 E., quarter corner between secs. 27 and 34, crossroads	40 14 16.9	88 23 36.6
T. 21 N., R. 7 E., corner secs. 28, 29, 32, and 33, T road north	40 14 17.2	88 25 19.8
T. 21 N., R. 7 E., corner secs. 29, 30, 31, and 32, T road north	40 14 17.4	88 26 28.6
T. 21 N., R. 7 E., corner secs. 30, 31, west of T road east	40 14 17.4	88 27 36.9
T. 21 N., R. 6 E., corner secs. 25, 26, 35, and 36, T road north	40 14 16.1	88 28 45.8
Mansfield, 1.5 miles north of; T. 21 N., R. 6 E., corner secs. 26, 27, 34, and 35, 0.5 mile west of; in northwest corner of S. J. Trimmer's field at east and west road crossing, in limestone 30 by 10 by 8 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 10"	40 14 15.9	88 30 08.7
Mansfield, crossing of Wabash Railway and "Big Four" Railway	40 12 51.1	88 30 39.6
Mansfield, T road north at Cemetery 1.5 miles south of	40 11 34.6	88 30 19.3
T road west	40 10 16.0	88 30 02.3
T. 20 N., R. 6 E., corner secs. 26, 27, 34, and 35, crossroads at	40 09 23.6	88 30 01.9
T. 20 N., R. 6 E., south corner secs. 34, 35, T road north near	40 08 44.1	88 30 01.5
T. 19 N., R. 6 E., quarter corner between secs. 2 and 3, crossroads near	40 08 04.5	88 30 04.6
Centerville, 1 mile south of; at T road west, in ground, in pasture owned by W. L. Alexander, 1.5 feet from north and south fence on east side of road, in stone 8 by 9 by 30 inches, alum. tab. stamped "Prim. Trav. Sta. No. 11"	40 06 19.6	88 30 03.3

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 19 N., R. 6 E., corner secs. 22, 23, 14, and 15, T road east	40 05 53.6	88 30 03.3
T. 19 N., R. 6 E., corner secs. 22, 23, 26, and 27	40 05 01.5	88 30 03.1
T. 19 N., R. 6 E., corner secs. 26, 27, 34, and 35, T road west	40 04 08.8	88 30 03.3
T. 19 N., R. 6 E., south corner secs. 34, 35	40 03 16.8	88 30 02.9
T. 18 N., R. 6 E., corner secs. 2, 3, 10, and 11, crossroads	40 02 24.1	88 30 02.4
T. 18 N., R. 6 E., corner secs. 10, 11, 14, and 15, crossroads	40 01 31.4	88 30 01.9
T. 18 N., R. 6 E., corner secs. 14, 15, 22, and 23	40 00 38.8	88 30 02.0
T. 18 N., R. 6 E., in northwest corner secs. 36, at crossroads, just inside of field and 3 feet from corner of hedge fence, iron post stamped "Prim. Trav. Sta. No. 12 1905"	39 59 45.8	88 30 01.2
T. 18 N., R. 6 E., corner secs. 23, 24, 25, and 26, crossroads	39 59 46.6	88 28 53.1
T. 18 N., R. 6 E., east corner secs. 24, 25, T road west	39 59 47.0	88 27 44.6
T. 18 N., R. 7 E., corner secs. 19, 20, 29, and 30, crossroads	39 59 46.9	88 26 39.0
T. 18 N., R. 7 E., corner secs. 20, 21, 28, and 29, crossroads	39 59 47.3	88 25 30.4
T. 18 N., R. 7 E., corner secs. 21, 22, 27, and 28, crossroads	39 59 47.5	88 24 22.1
T. 18 N., R. 7 E., corner secs. 22, 23, 26, and 27, crossroads	39 59 47.5	88 23 13.5
T. 18 N., R. 7 E., in southeast corner secs. 23, near southeast corner of L. W. Schrader's barn lot, at crossroads, 15 feet east to maple tree, iron post stamped "Prim. Trav. Sta. No. 13, 1905"	39 59 47.6	88 22 05.6
T. 18 N., R. 7 E., east corner of secs. 24 and 25, crossroads, is 15 feet south of corner	39 59 47.8	88 20 56.6
T. 18 N., R. 8 E., corner secs. 19, 20, 29, and 30, crossroads	39 59 47.2	88 19 53.4
T. 18 N., R. 8 E., corner secs. 20, 21, 28, and 29, crossroads	39 59 46.8	88 18 45.8
T. 18 N., R. 7 E., corner secs. 21, 22, 27, and 28, crossroads	39 59 46.1	88 17 37.7
T. 18 N., R. 7 E., corner secs. 22, 23, 26, and 27, crossroads	39 59 45.2	88 16 29.7

LOGAN, MENARD, AND SANGAMON COUNTIES.

SPRINGFIELD QUADRANGLE.

The following geographic positions were obtained from primary traverse by Mr. E. L. McNair, topographer, in 1905. The line starts from adjusted position at Tice, follows wagon roads east, south, and west near border of quadrangle, and is connected with adjusted position at the crossing of the Wabash and Alton railways in South

Springfield. Starting again from adjusted position at Athens the line follows wagon roads south along west border of quadrangle and is connected to adjusted position at Curran, at the crossing of the Wabash and the Chicago, Peoria and St. Louis railways. Positions are given on the Springfield astronomic datum.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Tice station	39 59 07.7	89 47 42.8
Tice, 3 corners 1.25 miles north of	40 00 15.7	89 47 41.6
T. 18 N., R. 6 W., quarter corner between secs. 16 and 21	40 00 16.0	89 46 50.6
T. 18 N., R. 6 W., in northeast corner sec. 22, road south	40 00 02.8	89 45 45.4
T. 18 N., R. 6 W., in northeast corner sec. 23, iron post stamped "Prim. Trav. Sta. No. 1, 1905"	40 00 10.5	89 44 17.5
Indian Point Presbyterian Church, road south, 1,800 feet west of, T. 18 N., R. 6 W., sec. 24, northwest corner of	40 00 11.4	89 43 46.4
T. 18 N., R. 5 W., quarter corner northeast quarter sec. 19 and southeast quarter sec. 18, T road west	40 00 16.2	89 41 56.6
T. 18 N., R. 5 W., corner secs. 16, 17, 20, and 21, T road east	40 00 17.1	89 40 31.8
T. 18 N., R. 5 W., corner secs. 15, 16, 21, and 22	40 00 17.4	89 39 23.9
T. 18 N., R. 5 W., corner secs. 14, 15, 22, and 23, 4 corners	40 00 17.7	89 38 14.7
T. 18 N., R. 5 W., quarter corner between secs. 23 and 24	39 59 51.9	89 37 06.3
T. 18 N., Rs. 4 and 5 W., quarter corner between secs. 19 and 24, Fancy Prairie station, crossing C. & A. Railway just south of	39 59 52.2	89 35 58.7
T. 18 N., R. 4 W., quarter corner between secs. 19 and 20, T road west	39 59 53.0	89 34 43.8
T. 18 N., R. 4 W., corner secs. 16, 17, 20, and 21	40 00 19.7	89 33 35.4
T. 18 N., R. 4 W., corner secs. 15, 16, 21, and 22, T road south	40 00 20.2	89 32 27.0
T. 18 N., R. 4 W., corner secs. 14, 15, 22, and 23	40 00 20.5	89 31 19.2
C. & A. Railway, crossing of	39 59 30.6	89 30 44.5
T. 18 N., R. 4 W., quarter corner between secs. 26 and 35, 4 corners	39 58 36.6	89 30 43.6
T. 18 N., Rs. 3 and 4 W., corner secs. 25, 36, 30, and 31, 4 corners	39 58 36.7	89 29 01.6
Williams, T. 18 N., Rs. 3 and 4 W., secs. 25, 36, 30, and 31, in northeast corner of town of, 30 feet northeast of intersection of roads, iron post stamped "Prim. Trav. Sta. No. 2"	39 58 36.9	89 29 01.4
Ts. 17 and 18 N., Rs. 3 and 4 W., corner of, 4 corners	39 57 44.4	89 29 01.5
T. 17 N., Rs. 3 and 4 W., quarter corner between secs. 12 and 7, T road north	39 56 26.0	89 29 00.6
T. 17 N., R. 4 W., quarter corner between secs. 12 and 13, road west	39 55 59.4	89 29 34.6

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 17 N., R. 4 W., quarter corner between secs. 13 and 24, T road east	39 55 07.1	89 29 34.3
T. 17 N., R. 4 W., quarter corner between secs. 24 and 25, T road east	39 54 15.2	89 29 33.8
T. 17 N., R. 4 W., quarter corner between secs. 25 and 36, 4 corners	39 53 22.8	89 29 33.3
Ts. 16 and 17 N., R. 4 W., quarter corner secs. 1 and 36, 1.25 miles east of Barclay; 3.5 feet in ground, iron post stamped "Prim. Trav. Sta. No. 3, 1905"	39 52 30.1	89 29 32.7
Ts. 16 and 17 N., R. 4 W., quarter corner secs. 2 and 35, 0.25 mile east of Barclay, 4 corners	39 52 29.4	89 30 41.2
T. 16 N., R. 4 W., quarter corner between secs. 2 and 11, T road north	39 51 37.0	89 30 40.4
Interurban Electric Railway, T. 16 N., R. 4 W., on line of secs. 11 and 14, crossing of	39 50 44.4	89 30 23.0
T. 16 N., R. 4 W., center sec. 23, T road north	39 49 27.6	89 30 42.0
T. 16 N., R. 4 W., near center of sec. 24, 4 corners	39 49 28.4	89 29 48.0
T. 16 N., R. 4 W., on line secs. 25 and 26, T road north	39 48 11.9	89 29 13.7
T. 16 N., R. 4 W., corner secs. 25, 26, 35, and 36, T road south	39 48 12.4	89 30 05.8
Ts. 15 and 16 N., quarter corner sec. 2	39 47 19.6	89 30 31.2
T. 15 N., R. 4 W., northeast quarter sec. 11, T road east	39 46 13.9	89 30 12.7
T. 15 N., R. 4 W., quarter corner secs. 13 and 14, 1.9 miles east of Rochester; near T road north, iron post stamped "Prim. Trav. Sta. No. 4, 1905"	39 45 01.3	89 29 54.2
Rochester, T. 15 N., R. 4 W., southwest quarter of sec. 15, 4 corners	39 45 00.8	89 32 03.2
T. 15 N., R. 4 W., in northeast corner sec. 17, T road south	39 45 12.4	89 33 35.5
T. 15 N., R. 4 W., in northwest corner sec. 17, T road south	39 45 21.2	89 34 08.5
T. 15 N., R. 4 W., quarter corner between secs. 18 and 19, 4 corners	39 44 39.9	89 34 41.5
T. 15 N., R. 4 W., north part of sec. 30, T road west	39 43 40.0	89 34 57.2
T. 15 N., R. 5 W., in northeast corner sec. 25, center of bridge over Sugar Creek	39 43 40.4	89 35 46.2
T. 15 N., R. 5 W., in southeast corner sec. 23, T road east	39 44 12.8	89 36 57.1
T. 15 N., R. 5 W., corner secs. 14, 15, 22, and 23, Illinois Central Railroad crossing	39 44 37.7	89 37 48.2
T. 15 N., R. 5 W., quarter corner between secs. 15 and 22, 4 corners	39 44 36.6	89 38 38.2
Wabash and Alton railways, crossing of, T. 15 N., R. 5 W., in northeast corner of sec. 12	39 46 19.0	89 39 09.0
THENCE ALONG WEST BORDER OF QUADRANGLE.		
Athens station, T. 18 N., R. 6 W., in sec. 36	39 57 53.1	89 43 27.9
T. 17 N., R. 6 W., quarter corner between secs. 11 and 12, 4 corners	39 56 20.0	89 43 38.1

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 17 N., R. 6 W., quarter corner between secs. 12 and 13, 4 corners	39 55 27.6	89 43 37.0
T. 17 N., R. 6 W., center sec. 24, 4 corners	39 54 35.4	89 43 19.0
T. 17 N., R. 6 W., sec. 23, center of pier of bridge over Sangamon River	39 54 27.5	89 44 32.8
T. 17 N., R. 6 W., quarter corner between secs. 27 and 28, T road south	39 53 43.7	89 45 47.3
T. 16 N., R. 6 W., center of southeast quarter sec. 3, T road west	39 51 46.4	89 45 15.4
T. 16 N., R. 6 W., near center sec. 10, in grass triangle near T road west, iron post stamped "Prim. Trav. Sta. No. 5, 1905"	39 51 14.2	89 45 32.3
T. 16 N., R. 6 W., north part sec. 22, 4 corners	39 49 44.7	89 45 30.1
T. 16 N., R. 6 W., north part sec. 27, T road west	39 48 44.5	89 45 30.1
T. 16 N., R. 6 W., center sec. 34, T road north	39 47 39.4	89 45 28.0
Ts. 15 and 16 N., quarter corner sec. 3, T road south	39 47 13.2	89 45 12.1
T. 15 N., R. 6 W., quarter corner between secs. 10 and 15, 1 mile northeast of Curran, near T road north, iron post stamped "Prim. Trav. Sta. No. 6, 1905"	39 45 24.2	89 45 10.3
Wabash and Chicago, Peoria and St. Louis railways, crossing of	39 44 38.1	89 45 43.9

CHAMPAIGN COUNTY.

URBANA QUADRANGLE.

The following geographic positions on the United States standard datum were established from primary traverse run in 1905 by Mr. J. R. Ellis, assistant topographer. The line starts from east tower of Illinois Industrial School at Champaign, located by triangulation of the United States Lake Survey; follows Illinois Central Railroad to Tolono; thence east along Wabash Railroad to Homer, connecting with Lake Survey triangulation station, Lynn Grove, and Lake Survey triangulation station chimney at Sidney; thence by wagon road north along border of quadrangle to Thomasboro; thence southwest along Illinois Central Railroad to starting point.

Geographic positions along the Illinois Central Railroad between Champaign and Tolono.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Champaign, east tower Industrial School, U. S. Lake Survey triangulation station	40 06 32.9	88 13 37.8
Champaign, near southeast corner of Engineer Building, State University, in ground at cross sidewalks near; said building bears N. 26° 15′ W., distant 52.5 feet, iron post stamped "Prim. Trav. Sta. No. 1, 1905"	40 06 38.1	88 13 35.2
Champaign, road crossing 1.25 miles south of (west track)	40 05 40.2	88 14 40.5
Savoy, road crossing, 1 mile north of (west track)	40 04 08.6	88 14 55.0
Savoy station (west track)	40 03 14.8	88 15 03.5
Savoy station, road crossing 1 mile south of (west track).	40 02 22.0	88 15 11.9
T. 18 N., R. 8 E., corner secs. 11, 12, 13, and 14	40 01 29.3	88 15 15.6
Tolono, in southeast corner of lot at Commercial Hotel; southeast corner of C. H. Bell's store bears N. 28° 30′ E., distant 185 feet; southeast corner of hotel bears N. 4° E., distant 108 feet; iron post stamped "Prim. Trav. Sta. No. 2, 1905"	39 59 06.4	88 15 39.1

Geographic positions along the Wabash Railway near Tolono.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Tolono, road crossing north and south, 1.25 miles east of.	39 59 21.5	88 14 15.4
Tolono, road crossing north and south on section line	39 59 37.8	88 13 04.9

Geographic positions along the highways between Tolono and Sidney.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 18 N., R. 9 E., corner of secs. 20, 21, 28, 29, at crossroads	39 59 45.9	88 11 56.9
T. 18 N., R. 9 E., corner secs. 21, 22, 27, and 28, at crossroads	39 59 46.5	88 10 48.7
T. 18 N., R. 9 E., corner secs. 22, 23, 26, and 27, at crossroads	39 59 47.1	88 09 40.9
T. 18 N., R. 9 E., corner secs. 23, 24, 25, and 26, at crossroads	39 59 47.6	88 08 32.4
T. 18 N., Rs. 9 and 10 E., corner secs. 19, 24, 25, and 30, at crossroads	39 59 48.3	88 07 24.1
T. 18 N., Rs. 9 and 10 E., corner secs. 25, 30, 31, and 36, at crossroads	39 58 55.6	88 07 23.7
Ts. 17 and 18 N., Rs. 9 and 10 E., corner secs. 1, 6, 31, and 36, at crossroads	39 58 03.3	88 07 23.3
Lynn Grove triangulation station: In SW. ¼ of SE. ¼ sec. 31, T. 18 N., R. 10 E., 3 miles southeast of Philo Railway station. Station mark: A stone post 3 feet below surface with another directly over it as a surface mark	39 58 09.85	88 06 35.90
Black, east and west road crossing Frisco Railway	39 58 02.4	88 05 09.0

Geographic positions along the highways between Tolono and Sidney—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 18 N., R. 10 E., corner secs. 28, 29, 32 and 33, at crossroads	39 58 54.7	88 05 07.6
T. 18 N., R. 10 E., in southeast corner sec. 20, 4 feet from corner of hedge fence, iron post stamped "Prim. Trav. Sta. No. 3, 1905"	39 59 48.7	88 05 08.1
T. 18 N., R. 10 E., quarter corner between secs. 16 and 21, crossroads near	40 00 40.4	88 04 33.6
Sidney, Lake Survey triangulation station chimney	40 01 25.45	88 04 10.02

Geographic positions along the Wabash Railway east of Sidney.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Sidney, crossing of Wabash and Frisco railways, 1 mile east of	40 01 30.6	88 03 25.7
Road crossing north and south between secs. 11 and 12	40 01 40.5	88 01 43.6
Road crossing north and south between secs. 7 and 12	40 01 47.2	88 00 35.0
T. 18 N., R. 14 W., near quarter corner west side sec. 7, in southwest corner of field and just off right of way, iron post stamped "Prim. Trav. Sta. No. 4, 1905"	40 01 52.9	87 59 39.2

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Ts. 18 and 19 N., R. 11 E., and 14 W., 0.5 mile north of corner to secs. 6, 6, 31, and 31, T road west	40 03 28.7	87 59 40.1
Clark schoolhouse, crossroads at	40 04 34.7	87 59 40.0
T. 19 N., R. 11 E., 14 W., corner secs. 18, 18, and 19, 19, crossroads near	40 05 52.2	87 59 39.8
T. 19 N., R. 11 E., in northeast corner sec. 18, in corner of field owned by Lou Richards, 2.5 feet southwest of corner fence post and 133 feet south of Big Four Railway, in limestone 40 by 7 by 5 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 5, 1905"	40 06 45.0	87 59 39.9
T. 19 N., R. 11 E., 14 W., corner secs. 6, 6, and 7 and 7, crossroads	40 07 39.0	87 59 39.7
Ts. 19 and 20 N., R. 11 E., 14 W., corner secs. 6 and 6 and 31 and 31, crossroads	40 08 31.8	87 59 39.7
T. 20 N., R. 14 W., west corner secs. 30 and 31, at Union schoolhouse, T road east	40 09 23.9	87 59 39.8
T. 20 N., R. 11 E., 14 W., corner secs. 19, 19, and 30, 30	40 10 15.2	87 59 39.6
T. 20 N., R. 14 W., west corner secs. 18 and 19, T road east	40 11 06.9	87 59 39.7
T. 20 N., R. 14 W., west corner secs. 7 and 18, T road east	40 11 59.1	87 59 39.8
T. 20 N., R. 14 W., west corner secs. 6 and 7, T road east	40 12 50.7	87 59 39.9

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 20 N., Rs. 11 E., 14 W., north corner secs. 6 and 6, T. road south	40 13 29.8	87 59 40.2
T. 21 N., R. 11 E., southeast corner sec. 25, in southeast corner of Doctor McFarland's garden, corner secs. 25, 30, 31, and 36, T. 21 N., Rs. 10 and 11 E., bears S. 43° E., distant 55 feet, iron post stamped "Prim. Trav. Sta. No. 6, 1905"	40 14 23.1	88 00 06.2
T. 21 N., R. 10 E., corner secs. 25, 26, 35, and 36; crossroads	40 14 22.6	88 01 15.1
T. 21 N., R. 10 E., corner secs. 26, 27, 34, and 35; crossroads	40 14 22.3	88 02 23.8
T. 21 N., R. 10 E., corner secs. 27, 28, 33, and 34, at Flatville	40 14 22.2	88 03 32.7
T. 21 N., R. 10 E., corner secs. 28, 29, 32, and 33; crossroads	40 14 22.0	88 04 41.8
T. 21 N., R. 10 E., in northeast corner sec. 31, at crossroads, 1.5 feet from corner fence post, iron post stamped "Prim. Trav. Sta. No. 7, 1905"	40 14 21.3	88 05 51.7
T. 21 N., Rs. 9 and 10 E., corner secs. 30, 31, 36, and 25; crossroads	40 14 21.1	88 06 59.9
T. 21 N., R. 9 E., corner secs. 25, 26, 35, and 36; crossroads	40 14 20.8	88 08 08.7
Thomasboro, crossroads 0.5 mile southeast of	40 14 19.6	88 11 02.0

Geographic positions along the Illinois Central Railroad between Thomasboro and Champaign.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Milepost 792, east and west road crossing 470 feet south of, east track	40 13 27.0	88 11 44.2
Leverett, east and west road crossing 1 mile north of, east track	40 12 00.8	88 12 20.3
Leverett, east and west road crossing, east track	40 11 21.2	88 12 36.8
T. 20 N., R. 9 E., secs. 19 and 20, south corner of, T road north	40 10 15.6	88 13 12.8
Milepost 787, east and west road crossing, east track	40 09 22.9	88 13 26.3
Milepost 786, east and west road crossing, 230 feet south of, east track	40 08 30.1	88.13 48.3
Illinois Central Railway and Big Four Railway, crossing of, north track Big Four, east track Illinois Central Railway	40 07 17.9	88 14 17..7

IOWA.

PRIMARY TRAVERSE.

BOONE, DALLAS, POLK, AND STORY COUNTIES.

DES MOINES 30-MINUTE QUADRANGLE.

The following geographic positions were determined from primary traverse in 1904 by J. R. Ellis. The line starts from adjusted position near southwest corner of Des Moines Special quadrangle, follows Rock

Island Railway westward to west edge of quadrangle; thence north and east along wagon roads to northeast corner of quadrangle; thence south to Enterprise along Des Moines, Iowa Falls and Northern Railway, and is closed on adjusted position near northeast corner of Des Moines Special quadrangle. Positions are given on the Des Moines astronomic datum.

Geographic positions along the Chicago, Rock Island and Pacific Railway between Milepost 369 and Desoto.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Polk-Dallas County line, north and south railroad crossing on	41 32 17.8	93 47 19.0
Milepost 369, private road crossing 0.25 mile east of	41 32 13.0	93 48 22.5
Milepost 370, north and south road crossing 500 feet west of	41 32 57.6	93 49 52.8
Milepost 371, private road crossing 1,410 feet west of	41 31 42.9	93 51 12.5
Booneville, Iowa, in northwest corner of pasture owned by E. P. Farnsley, on south side of Chicago, Rock Island and Pacific Railway crossing, cross on southwest corner of foundation to station bears N. 59° 40′ E., distant 465.4 feet; south rail at center of crossing bears N. 80° 15′ W., distant 98 feet, iron post stamped "Prim. Trav. Sta. No. 9"	41 31 22.5	93 52 59.9
Booneville, private road crossing 1.25 miles west of	41 31 10.4	93 54 23.7
Milepost 375	41 31 28.6	93 55 20.5
Van Meter, road crossing 600 feet east of station	41 31 56.9	93 56 56.2
Spur, road crossing 275 feet northwest of	41 32 20.5	93 57 39.2
Bridge No. 362, road crossing 940 feet west of	41 31 55.9	93 58 57.0
Desoto, in northwest corner of public school grounds; southeast corner of J. C. Thrailkill's house bears S. 65° 45′ W., distant 94 feet, iron post stamped "Prim. Trav. Sta. No. 10"	41 31 57.3	94 00 22.3

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Desoto, road west 1 mile northwest of, 21 feet northeast to east end culvert, 30 feet northwest to cross cut on gatepost	41 32 46.8	94 00 34.5
South fork of Raccoon River, north end of bridge over	41 33 23.8	94 00 17.2
South fork of Raccoon River, T road east 0.75 mile north of; 21 feet northwest to cross cut on telephone pole, 36 feet northeast to cross cut on telephone pole	41 34 04.5	94 00 20.2
T road east, 40 feet southeast to cross cut on telephone pole, 42 feet northeast to cross cut on corner fence post	41 35 42.1	94 00 39.2
Adel, in southeast corner of court-house yard; northeast corner of cornerstone to court-house bears N. 29° 55′ W., 167.7 feet, water table at northeast corner of bank bears S. 15° 40′ E., distant 69.3 feet; iron post stamped "Prim. Trav. Sta. No. 11"	41 37 01.9	94 00 56.5
Adel, *center pier of bridge 1 mile north of*	41 38 05.0	94 01 18.0

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Schoolhouse No. 3, T road east at; 42 feet southwest to cross cut in telephone pole	41 38 50.3	93 01 16.0
Adel, crossroads, 3 miles north of; 33 feet southeast to Freeman's mail box; 30 feet northeast to guide post	41 39 29.4	94 01 16.1
Dallas County farm, T road east 0.75 mile north of; 39 feet southeast to cross cut on telephone pole, 40 feet northeast to cross cut on corner fence post	41 40 21.2	94 01 15.8
Dallas Center, crossroads 3 miles west of, 32 feet southeast to guide post, 30 feet northeast to cut on telephone pole.	41 41 17.5	94 01 19.6
Schoolhouse, crossroads 0.25 mile south of; 33 feet southeast to cross cut on fence post, 38 feet southwest to cross cut on telephone pole	41 41 56.7	94 01 21.8
T. 29 N., R. 27 W., sec. 30, T road south, near, 40 feet southwest to cross cut on telephone pole, 31 feet southeast to cross cut on corner post	41 43 15.5	94 01 16.5
T road west; 36 feet southwest to mail box, 31 feet northwest to cross cut on telephone pole	41 43 54.9	94 00 59.3
Minburn, north and south road crossing of, Chicago, Rock Island and Pacific Railway, 1 mile southeast of	41 44 43.3	94 01 00.5
Minburn, 0.5 mile east of; in northeast corner of field owned by E. S. Hill at T road south, nail in blaze on west face of pine tree bears N. 87° 20′ E., distant 63.7 feet; same on northwest face of maple tree bears S. 41° 20′ E., distant 103 feet	41 45 13.4	94 01 01.1
Quarter corner, crossroads at, 33 feet southwest to cross cut on corner fence post 39 feet northwest to mail box.	41 45 13.6	93 59 15.6
Ts. 80 and 81 N., R. 27 W., secs. 3, 4, 33, and 34, corner of, crossroads at	41 46 36.6	93 59 14.4
T. 81 N., R. 27 W., corner secs. 27, 28, 33, and 34, crossroads at	41 47 28.9	93 59 14.7
T. 81 N., R. 27 W., quarter corner to secs., 22 feet east to crossroads	41 48 21.1	93 59 14.7
Chris Hargin's mail box, 29 feet northwest to cross cut on fence post	41 48 21.1	93 59 14.8
T. 81 N., R. 27 W., secs. 21, 22, T road north 0.25 mile west of; 6 feet to stone in road, 25 feet to cross cut on corner fence post	41 49 13.6	93 59 32.2
T. 81 N., R. 27 W., quarter corner between secs. 16 and 17, T road north	41 49 39.8	94 00 25.6
T road east, 30 feet northwest to cross cut on fence post, 30 feet northeast to cross cut on corner fence post	41 50 32.3	94 00 25.8
Benton, railway crossing, 130 feet west of station	41 51 10.1	94 00 25.5
Benton, 1 mile north of, T. 81 N., R. 27 W., in northwest corner of section 4, on land owned by Hans Meyer, at crossroads, iron post stamped "Prim. Trav. Sta. No.13".	41 51 46.5	94 00 25.2
T. 82 N., R. 27 W., corner secs. 28, 29, 32, and 33, crossroads	41 52 39.4	94 00 25.5
T. 82 N., R. 27 W., corner secs. 21, 22, 27, and 28, crossroads at	41 53 31.0	93 59 15.2
T. 82 N., R. 27 W., corner secs. 15, 16, 21, and 22, crossroads at	41 54 23.4	93 59 15.6

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
T. 82 N., R. 27 W., corner secs. 9, 10, 15, and 16, crossroads at	° ′ ″ 41 55 15.8	° ′ ″ 93 59 16.3
T. 82 N., R. 27 W., corner secs. 3, 4, 9, and 10, crossroads at	41 56 08.4	93 59 16.3
Ts. 82 and 83 N., R. 27 W., corner secs. 3, 4, 33, and 34, crossroads at	41 57 00.6	93 59 15.3
T. 83 N., R. 27 W., corner secs. 27, 28, 33, and 34, crossroads at	41 57 52.6	93 59 14.8
T. 83 N., R. 27 W., corner secs. 27, 28, 21, and 22, crossroads at	41 58 44.6	93 59 14.4
Schoolhouse No. 7, in northwest corner to school yard, T. 83 N., R. 27 W., northwest corner sec. 22; northwest corner foundation bears S. 15° 45′ E., distant 153 feet; section corner bears N. 52° 30′ W., distant 40 feet; iron post stamped "Prim. Trav. Sta. No. 14"	41 59 36.4	93 59 14.0
T. 83 N., R. 27 W., corner secs. 14, 15, 22, and 23, corner of T road south at	41 59 36.5	93 58 04.6
T road north, 33 feet northwest to bowlder, 39 feet northeast to cross cut on telephone pole	41 59 36.5	93 57 14.0
T. 83 N., Rs. 26 and 27 W., corner secs. 18, 19, 24, and 13, T road west	41 59 36.6	93 55 45.2
Des Moines River, center pier of bridge	41 59 56.4	93 54 06.9
T road south, near large elm tree	41 59 34.6	93 53 12.6
Luther station, 2 miles north and 3 miles west of; T. 83 N., R. 26 W., in southwest corner sec. 15, in corner of pasture owned by R. N. Cartwright; stone at corner secs 15, 16, 21, and 22 bears S. 38° 40′ W., distant 35.7 feet; iron post stamped "Prim. Trav. Sta. 15"	41 59 37.5	93 52 18.8
T. 83 N., R. 26 W., corner secs. 22 and 23, 14 and 15, T road south	41 59 38.1	93 51 09.3
T. 83 N., R. 26 W., corner secs. 13, 14, 23, and 24, T road north	41 59 38.7	93 49 58.9
T. 83 N., Rs. 25 and 26 W., corner secs. 18, 19, 24, and 13, crossroads at	41 59 38.2	93 48 48.8
T. 83 N., R. 25 W., corner secs. 17, 18, 19, and 20, crossroads at	41 59 38.0	93 47 37.9
T. 83 N., R. 25 W., corner secs. 16, 17, 20, and 21, crossroads at	41 59 38.8	93 46 28.7
School No. 5, T. 83 N., R. 25 W., sec. 15, in and near southwest corner school yard; section corner to secs. 15, 16, 22, and 21 bears N. 45° W.; iron post stamped "Prim. Trav. Sta. No. 16"	41 59 39.1	93 45 17.9
T. 83 N., R. 25 W., corner secs. 14, 15, 22, and 23, crossroads at	41 59 38.2	93 44 08.5
T. 83 N., R. 25 W., corner secs. 13, 14, 23, and 24, crossroads at	41 59 38.1	93 42 58.0
T. 83 N., R. 24 and 25 W., corner secs. 18, 19, 24, and 13, crossroads at	41 59 37.3	93 41 48.1
T. 83 N., R. 24 W., corner secs. 17, 18, 19, and 20, crossroads at	41 59 37.4	93 40 36.1

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 83 N., R. 24 W., corner secs. 17, 18, 7, and 8, T road west at	42 00 29.8	93 40 36.3
T road south, 31 feet north to Willow tree, 50 feet southwest to cottonwood	42 00 42.2	93 39 25.9
Ames, in southeast corner of Agricultural College grounds, southwest corner of foundation to porch of house bears N. 51° 10′ E., distant 169.7 feet; southeast corner foundation to first house north of southeast corner bears N. 13° W., distant 129.5 feet, iron post stamped "Prim. Trav. Sta. No. 17"	42 01 21.5	93 38 25.4
T road north at section corner (no numbers), 33 feet southwest to electric-light reel on post, 27 feet northeast to cross cut on telephone pole	42 01 21.8	93 37 06.0
Skunk ditch, center of bridge over	42 01 21.2	93 35 38.8
Stone corner secs. (no numbers), 36 feet northwest to J. C. Marsh's mail box, 36 feet northeast to cross cut on telephone pole	42 01 21.0	93 34 46.4
T. 83 N., R. 24 W., secs. 4, 5, 8, and 9, corner of, crossroads at schoolhouse	42 01 22.4	93 32 20.6
T. 83 N., R. 24 W., corner secs. 8, 9, 16, and 17, crossroads	42 00 30.2	93 32 20.6
T. 83 N., R. 24 W., corner secs. 16, 17, 20, and 21, crossroads	41 59 37.9	93 32 20.6
T. 83 N., R. 24 W., corner secs. 15, 16, 21, and 22, crossroads	41 59 38.0	93 31 10.6
T. 83 N., R. 24 W., in northeast corner of northwest quarter sec. 22, at T road south, nail in root of willow tree bears N. 79° 30′ E., distant 99 feet; west end of culvert bears N. 26° E., distant 9 feet, iron post stamped "Prim. Trav. Sta. No. 18"	41 59 37.7	93 30 35.8

Geographic positions along the Des Moines, Iowa Falls and Northern Railroad.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Shipley, north and south road crossing 0.25 mile west of	41 58 39.6	93 30 35.6
Quarter corner at crossroads, 43 feet northwest to cross cut on schoolhouse fence, 39 feet southwest to cross cut on fence post	41 57 53.2	93 30 35.9
Quarter corner at crossroads, 38 feet northeast to cross cut on telephone pole, 37 feet southeast to T. P. Child's mail box	41 57 00.9	93 30 36.7
Quarter corner at crossroads, 42 feet northwest to D. C. Hanks's mail box, 39 feet southwest to cross cut on telephone pole	41 56 07.4	93 30 36.7
T road west, 41 feet northwest to cross on corner fence post, 39 feet southwest to cross on telephone pole	41 55 15.5	93 30 36.3
Cambridge, east and west road crossing 0.5 mile north of	41 54 05.0	93 31 25.9
Cambridge, crossing Chicago, Milwaukee and St. Paul Railway and Des Moines, Iowa Falls and Northern Railroad	41 53 39.1	93 31 21.3

Geographic positions along the Des Moines, Iowa Falls and Northern Railroad—Cont'd.

Station.	Latitude.	Longitude.
Cambridge, 1.5 miles south of; in northeast corner of Perry Crook's field, west rail of railroad at crossing bears N. 61° E., distant 53 feet, iron post stamped "Prim. Trav. Sta. No. 19"	° ′ ″ 41 52 38.7	° ′ ″ 93 31 13.2
Story and Polk county line, crossing with railway	41 51 46.9	93 31 05.2
Milepost 21, east and west road crossing 110 feet south of	41 50 57.3	93 30 58.3
Milepost 20, east and west road crossing 270 feet south of; also corner of secs. (no numbers)	41 50 04.9	93 31 12.2
Milepost 19, east and west road crossing 1,000 feet south of	41 49 06.5	93.31 27.8
Elkhart, east and west crossing 0.75 mile north of	41 48 20.5	93 31 28.4
Elkhart station	41 47 36.4	93 31 28.8
Milepost 16	41 46 39.5	93 31 29.5
Enterprise, east and west road crossing 2 miles north of	41 45 24.0	93 31 30.3
Enterprise, 1 mile north of; in southeast corner of J. Wohlwind's farm, on north side of east and west road, corner post of field bears SE., distant 2.5 feet, iron post stamped "Prim. Trav. Sta. No. 5"	41 44 46.2	93 31 31.4

POLK COUNTY.

DES MOINES SPECIAL QUADRANGLE.

The following geographic positions were determined from primary traverse in 1904 by Mr. J. R. Ellis, topographic aid. The line starts from north meridian stone in court-house yard at Des Moines, located by astronomic observations by the United States Coast and Geodetic Survey, and follows the Chicago Great Western Railway southwest to Orillia; thence north along public highways to northwest corner of quadrangle; thence east to Enterprise. The line follows Des Moines, Iowa Falls and Northern Railway for about three miles; thence runs south along public highways to Levey; thence northwest along Chicago, Rock Island and Pacific Railway to Des Moines, connecting with original position.

Geographic positions along the Chicago Great Western Railway between Des Moines and Orillia.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Des Moines, north meridian stone in court-house yard	41 35 05.6	93 37 16.9
Des Moines, Ninth street crossing Chicago Great Western Railroad, in south part of	41 34 18.7	93 37 17.6
South Des Moines, road crossing 0.5 mile west of station	41 33 57.8	93 38 35.0
Blacksmith shop, road crossing north and south	41 33 46.1	93 39 21.3
Millman, section line road crossing 1 mile north of	41 33 19.3	93 40 36.7

Geographic positions along the Chicago Great Western Railway, etc.—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 78 N., Rs. 24 and 25 W., corner secs. 19, 24, 25, and 30.	41 32 27.0	93 40 20.5
Milepost 318, road crossing 0.25 mile northeast of	41 31 34.5	93 41 29.2
Milepost 319, road crossing east and west 600 feet northeast of	41 31 08.8	93 42 37.0
Orillia, in south corner of triangular lot owned by G. W. Briggs; northeast corner of brick foundation to A. Muller's residence bears N. 63° 40′ W., distant 106.1 feet; northeast corner of brick foundation to R. G. Latimer's residence bears S. 77° 30′ W., distant 196.1 feet; iron post set 40 inches in the ground, stamped "Prim. Trav. Sta. No. 1"	41 30 37.1	93 43 47.5

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T road north, 42 feet northwest to cross on telephone pole	41 31 08.7	93 44 05.6
Bridge over branch north	41 31 34.9	93 45 00.9
Commerce, road crossing Chicago, Rock Island and Pacific Railroad, 600 feet east of station	41 32 12.6	93 45 26.8
T. 78 N., R. 25 W., corner secs. 19, 20, 29, and 30, at T road north, 28 feet west to cross on corner cedar fence post, 39 feet northeast to cross on telephone pole	41 32 27.2	93 46 07.3
T. 78 N., R. 25 W., corner secs. 17, 18, 19, and 20, 24 feet due east to railroad spike in tie used for fence post	41 33 19.3	93 46 08.1
T. 78 N., R. 25 W., corner secs. 7, 8, 17, and 18, at crossroads, 27 feet northwest to cross on fence post, 36 feet northeast to cross on fence post	41 34 11.6	93 46 08.2
T. 78 N., R. 25 W., corner secs. 5, 6, 7, and 8, at crossroads, 39 feet northwest to cross on telephone pole, 39 feet northeast to cross on fence post	41 35 03.7	93 46 08.4
T. 78 N., R. 25 W., corner secs. 5 and 6 (north corner), T road south, 30 feet north to front yard gate, 33 feet southeast to east end of stone culvert	41 36 01.0	93 46 09.5
T. 79 N., R. 25 W., corner secs. 28, 29, 32, and 33, T road east 0.25 mile north of; 33 feet southeast to iron corner fence post, 40 feet northeast to cross on corner fence post	41 37 03.0	93 46 22.6
T. 79 N., R. 25 W., corner secs. 20, 21, 28, and 29, T road south 0.5 mile east of; 28 feet northeast to cross on fence post, 42 feet southeast to cross on fence post	41 37 45.6	93 46 05.8
T. 79 N., R. 25 W., near southeast corner of sec. 21, on land owned by B. B. Harding, nail in blaze on west face of cottonwood tree bears N. 71° 30′ E., distant 29.6 feet; nail in blaze on south face of large water maple tree bears N. 14° 40′ E., distant 94.5 feet, iron post set 42 inches in ground, stamped "Prim. Trav. Sta. No. 2"	41 37 45.6	93 45 14.8
T. 79 N., R. 25 W., corner secs. 15, 16, 21, and 22, at crossroads; 33 feet northeast to cross on telephone pole, 33 feet northwest to cross on corner fence post	41 38 37.2	93 45 14.1

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
T. 79 N., R. 25 W., corner secs. 9, 10, 15, and 16, at crossroads, 21 feet northwest to John Everett's mail box, 24 feet northeast to cross on railing	° ′ ″ 41 39 29.9	° ′ ″ 93 45 13.9
T. 79 N., R. 25 W., corner secs. 3, 4, 9, and 10 at crossroads, 37 feet southeast to S. A. Richardson's mail box, 39 feet southwest to cross on corner fence post	41 40 22.0	93 45 13.8
T. 79 N., R. 25 W., corner secs. 3 and 4 (north corner), at T road south, 36 feet west to Bauman's mail box, 28 feet northwest to cross on telephone pole	41 41 17.3	93 45 13.6
T. 80 N., R. 25 W., corner secs. 27, 28, 33, and 34, T road west at, 13 feet southeast to P. Smith's mail box, 40 feet northeast to cross on corner fence post	41 42 09.8	93 45 13.4
T road east, 48 feet southeast to John McIntyre's mail box, 38 feet northeast to cross on corner post	41 43 16.5	93 45 13.8
Schoolhouse, T road west 0.25 mile south of; 35 feet northwest to cross on corner post, 31 feet southwest to cross on corner fence post	41 43 19.4	93 44 38.8
Andrews, 1 mile southeast of; in northwest corner of yard at forks of road, nail in root of post oak tree bears N. 71° 40′ W.; nail in blaze on post oak tree bears S. 11° 20′ W., iron post set 42 inches in ground, stamped "Prim. Trav. Sta. No. 3"	41 44 46.8	93 44 20.9
Cardon, iron bridge over Des Moines River, center pier of	41 44 44.2	93 42 28.1
T. 80 N., R. 24 W., quarter corner between secs. 17 and 18, at T road north; 18 feet south to cross on corner fence post, 27 feet northwest to cross on corner fence post	41 44 19.8	93 40 31.8
T. 80 N., R. 24 W., corner secs. 8, 9, 16, and 17, crossroads 0.25 mile east of; 17 feet southwest to Mr. Harley's mail box, 31 feet southeast to cross on corner fence post	41 44 45.9	93 39 05.0
T. 80 N., R. 24 W., near southeast corner of sec. 9, 80 feet west of corner fence post, 1 foot north of east and west fence, iron post set 38 inches in the ground, stamped "Prim. Trav. Sta. No. 4"	41 44 46.1	93 38 14.5
T. 80 N., R. 24 W., quarter corner between secs. 11 and 14, crossroads at, 39 feet northwest to cross on corner fence post, 39 feet northeast to cross on corner fence post	41 44 46.2	93 36 28.5
T. 80 N., Rs. 23 and 24 W., corner secs. 7, 12, 13, and 18, at crossroads; 35 feet southwest to cross on corner fence post, 37 feet southeast to cross on telephone pole brace	41 44 46.2	93 34 44.3
T. 80 N., R. 23 W., corner secs. 7, 8, 17, and 18, at T road north; 35 feet northeast to mail box, 50 feet northwest to cross on corner fence post	41 44 46.0	93 33 31.3
T. 80 N., R. 23 W., corner secs. 8, 9, 16, and 17, at crossroads, 35 feet northeast to H. W. Long's mail box, 50 feet northwest to cross on fence post	41 44 46.0	93 32 22.4

Geographic positions along the Des Moines, Iowa Falls and Northern Railway near Enterprise.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Enterprise station	41 43 58.6	93 31 41.4
Milepost 12, private road crossing east and west 1,950 feet south of	41 42 53.6	93 31 49.1
Enterprise, section line road crossing 2 miles south of	41 42 09.7	93 31 49.4

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Ts. 79 and 80 N., R. 23 W., corner secs. 3, 4, 33, and 34, at crossroads, 39 feet northeast to mail box on corner fence post; 44 feet southeast to cross on telephone pole.	41 41 17.5	93 31 14.1
T. 79 N., R. 23 W., corner secs. 3, 4, 9, and 10, at crossroads at schoolhouse, 32 feet southeast to cross on corner schoolhouse yard fence, 33 feet northeast to cross on corner fence post	41 40 22.4	93 31 13.8
T. 79 N., R. 23 W., corner secs. 9, 10, 15, and 16, at crossroads, 40 feet southeast to James Watts's mail box; 39 feet northeast to cross on corner fence post	41 39 30.3	93 31 13.8
T. 79 N., R. 23 W., at crossroads at corner secs. 15, 16, 21, and 22, at southwest corner of West Schoolhouse yard, southwest corner of foundation to schoolhouse bears N. 58° 45′ E., distant 70.7 feet; north rail of electric railroad at center of north and south road crossing bears S. 3° 00′ W., distant 163 feet from iron post stamped "Prim. Trav. Sta. No. 6"	41 38 38.3	93 31 13.1
T. 79 N., R. 23 W., corner secs. 21, 22, 27, and 28, at T road north, 45 feet northeast to cross on telephone pole, 39 feet northwest to cross on telephone pole	41 37 46.0	93 31 13.7
T. 79 N., R. 23 W., corner secs. 22, 23, 26, and 27, at T road west	41 37 45.9	93 30 04.9
T. 79 N., R. 23 W., quarter corner between sections 34 and 35, north and south road crossing Chicago, Rock Island and Pacific Railroad near	41 36 29.1	93 30 05.9
Township line road crossing east and west	41 36 01.3	93 31 03.4
Youngstown, west end of wagon bridge over Fourmile Creek	41 34 59.0	93 31 53.5
T. 78 N., R. 23 W., quarter corner between secs. 8 and 17 at T road south, 18 feet northeast to H. Wilson's mail box, 42 feet northwest to cross on telephone pole	41 34 06.3	93 31 40.0
Levey, on west side of north and south road, on property of E. S. Irwin, northeast corner of brick foundation to Irwin's residence, bears N. 21° 50′ W., distant 174.5 feet; five nails in large telephone pole bear S. 54° 15′ E., distant 54 feet; iron post stamped "Prim. Trav. Sta. No. 7"	41 32 50.9	93 31 23.2

Geographic positions along the Chicago, Rock Island and Pacific Railroad between Levey and Des Moines.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Levey, Chicago, Rock Island and Pacific Railroad, at east and west road crossing, 0.5 mile southwest of	41 32 35.3	93 31 49.5
Brick works, private road crossing just north of	41 33 17.8	93 33 37.7
Milepost 361, private road crossing 790 feet southeast of	41 33 58.9	93 34 18.9
Des Moines, crossing Chicago, Rock Island and Pacific Railroad, and Chicago, Burlington and Quincy Railroad in east part of	41 34 45.7	93 34 33.3
Des Moines, crossing Chicago, Burlington and Quincy and electric railroads at Scott street, in east part of	41 35 00.3	93 35 26.2
Des Moines, in southeast corner of granite base to statue at west entrance to State house grounds, aluminum tablet stamped "Prim. Trav. Sta. No. 8"	41 35 26.3	93 36 12.5
Azimuth of K. D. & F. D. R. R., 0.75 mile west of Ashawa=278° 18′ 50″.		
Azimuth of C., M. & St. P. R. R. at road crossing near secs. 21, 22, 27, 28, T. 79 N., R. 25 W.=146° 10′ 15″.		
Azimuth of C. & N. W. R. R. at east and west sec. line road crossing 1.5 mi. N. of Ankeny=306° 32′ 20″.		
Azimuth of C., B. & Q. R. R. at Levey=330° 30′ 10″.		

KENTUCKY.

PRIMARY TRAVERSE.

UNION COUNTY.

MORGANFIELD QUADRANGLE.

The following geographic positions were located by Mr. J. R. Ellis, topographic aid, in 1904. The line starts from a position determined by primary traverse at Free Union and follows public highway via Hearin post-office to Sullivan; thence along Illinois Central Railroad to Sturgis; thence along public highway via Grove Center to Uniontown, where the line connects with another position previously located by primary traverse.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Free Union; hub	37 31 29.4	87 45 43.1
Ashland Church, T road southeast about 0.25 mile northeast of, 22 feet east to corner of picket fence, 22 feet north to telephone brace	37 30 41.2	87 47 23.6
Rice's residence, T road north; 21 feet north to corner post to wire fence, 30 feet southeast to corner of yard fence	37 31 26.0	87 48 46.5

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T road southeast, 21 feet northwest to corner of board fence, 25 feet southeast to telephone pole	37 31 40.4	87 49 35.7
Hearin post-office, in east corner of Mrs. Jennie Nall's garden, east corner of blacksmith shop bears N. 50° 30′ W., distant 141 feet; north corner of Mrs. Nall's residence bears S. 25° 15′ W., distant 63 feet, sandstone post 8 by 15 by 36 inches set 30 inches in ground, with bronze tablet cemented in top, stamped "Prim. Trav. Sta. No. 9"	37 32 07.3	87 50 52.7
T road southwest, 21 feet south to corner of picket fence	37 32 19.9	87 52 09.0
T road north at bridge over creek southwest, 24 feet northeast to corner gatepost, 35 feet west to center of bridge	37 32 31.6	87 52 37.6
Wynne bridge, center of	37 32 37.4	87 54 10.5
T road northeast, 15 feet to easternmost gatepost, 40 feet northeast to corner picket fence	37 32 09.5	87 54 14.2
T road southwest at bridge over ditch, 21 feet north to large black oak tree at corner picket fence, 12 feet south to corner of bridge over ditch	37 31 20.8	87 54 30.2
T road northeast, 10 feet southwest to bill post and stump, 20 feet northwest to center of small bridge	37 30 52.4	87 55 03.5
T road northeast at schoolhouse, 30 feet east to corner of picket fence, 21 feet northwest to center of small bridge	37 30 30.5	37 55 48.0
Sullivan, T road northwest about 0.75 mile northeast of, 25 feet north to rail-and-picket fence	37 30 23.0	87 56 12.4
Sullivan, in north corner of Jno. McGraw's front yard, northeast corner of McGraw's house bears S. 33° 45′ E., distant 16.6 feet; east corner of house opposite McGraw's bears N. 62° 15′ W., distant 70.4 feet. Bronze tablet cemented in top of sandstone post 8 by 9 by 26 inches, set 22 inches in ground, stamped "Prim. Trav. Sta. No. 10"	37 29 58.8	87 56 37.1

Geographic positions along the Illinois Central Railroad between Sullivan and Sturgis.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Milepost 72, private road crossing 600 feet northwest of	37 30 21.5	87 57 09.3
Road crossing east and west 800 feet northwest of milepost 73	37 31 03.9	87 57 59.0
Road crossing east and west at milepost 74	37 31 39.4	87 58 31.6
Road crossing 270 feet north of milepost 75	37 32 29.8	87 58 52.5
Sturgis, Adams street, crossing north and south	37 32 48.5	87 59 03.6

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Sturgis, center of iron bridge over Cypress Creek about 1 mile north of	37 33 31.0	87 58 46.2
T road west about 0.75 mile north of bridge over Cypress Creek, 30 feet southwest to large elm tree at corner of fence, 27 feet east of telephone pole	37 34 06.3	87 58 31.4
T road northeast, 25 feet northeast to corner of stable lot fence, 33 feet to corner of picket fence	37 34 15.9	87 59 28.3
Crossroads at hackberry tree, 15 feet northeast to hackberry tree, 21 feet west to corner of rail fence	37 34 48.3	87 59 31.9
T road east, 20 feet southeast to telephone pole, 30 feet northwest to large gum tree	37 34 51.4	88 00 13.7
T road west where telephone line branches west; 10 feet west to center of small bridge	37 36 11.2	88 00 19.8
Gum grove, in northeast corner of Ben F. Perkins's front yard, northeast corner of his residence bears S. 56° 45′ W. distant 39.9 feet; east face of silver poplar tree bears N. 51° W. distant 34.4 feet; telephone pole bears N. 32° E. distant 6 feet, aluminum tablet in top of sandstone post 7 by 12 by 24 inches, set 22 inches in ground, stamped "Prim. Trav. Sta. No. 11"	37 37 00.8	88 00 19.6
Grove Center, intersection of roads 1 mile south of, 28 feet north to J. L. Geiger's mail box, 28 feet southeast to corner of wire fence	37 37 49.4	88 00 37.8
Grove Center, road crossing Illinois Central Railroad at station	37 38 29.3	88 00 43.5
Blue bridge (covered) over Heins Creek west	37 39 39.4	88 01 05.4
Lane east, 28 feet east to corner of hedge fence, 27 feet southeast to corner of rail and picket fences	37 40 08.0	88 00 51.1
Woodgrove Church, intersection of Morganfield and Springgrove road and road southeast ¼ mile southwest of, 36 feet southwest to stone at corner of garden fence 30 feet east to corner of picket fence	37 41 04.1	88 00 51.1
Woodgrove Church, T road ¼ mile east of, 24 feet west to corner of culvert	37 41 16.5	88 00 26.1
T road west at F. Thomas's residence, 18 feet northwest to hickory tree, 23 feet east to mail box	37 41 41.1	88 00 19.2
T road east, 21 feet east to John Masons's mail box	37 42 47.0	87 59 30.4
T road west, 24 feet northeast to corner of picket fence, 27 feet southwest to corner of picket fence	37 43 23.2	87 59 08.4
Uniontown, 4 miles southwest of, hickory tree 16 inches in diameter bears N. 69° 45′ E., 35.2 feet distant, southwest corner of John Thompson's tenement house bears S. 53° E. distant 49.5 feet, aluminum tablet cemented in top of sandstone post 7 by 12 by 26 inches, set 23 inches in ground, in John Thompson's tenement-house yard, 1½ feet east of front fence and 6 feet south of stile, stamped "Prim. Trav. Sta. No. 12"	37 43 56.3	87 58 41.8
T road east, 33 feet due south to corner of rail and picket fences; this T road is 130 feet south of top of hill	37 45 05.3	87 57 50.4
T road north just east of creek, 35 feet north to corner of rail and wire fence	37 45 54.0	87 57.19.2

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Uniontown, in south part of, in south corner of R. H. Sooper's tobacco factory property, nail in black oak tree bears N. 23° 30′ W., distant 10.2 feet; south corner of tobacco factory (main building) bears N. 25° 15′ E., distant 103.9 feet; corner post to south corner fence is 4.6 feet distant, aluminum tablet cemented in top of sandstone 7 by 13 by 26 inches, set 23 inches in ground, stamped "Prim. Trav. Sta. No. 13"	° ′ ″ 37 46 14.6	° ′ ″ 87 56 16.6
Uniontown, Mill street crossing Illinois Central Railroad.	37 46 06.2	87 55 53.9

MAINE.

TRIANGULATION STATIONS.

KNOX AND WALDO COUNTIES.

BELFAST QUADRANGLE.

In the fall of 1904, Mr. E. L. McNair, topographer, located six new stations for the control of this quadrangle. These stations were based upon Harris and Ragged of the United States Coast and Geodetic Survey. Positions are given on the United States standard datum.

RAGGED, KNOX COUNTY.

A United States Coast and Geodetic Survey station on summit of high mountain, 4 miles southwest of village of Camden.

Station mark: A copper bolt in solid rock.

Reference marks: Seven iron ring bolts at foot of quadripod legs. No. 1, distant 6.6 feet; azimuth, 196° 10′. No. 2, distant 6.2 feet; azimuth, 203° 23′. No. 3, distant 6.9 feet; azimuth, 287° 08′. No. 4, distant 7 feet; azimuth, 309° 21′. No. 5, distant 7 feet; azimuth, 25° 57′. No. 6, distant 8.5 feet; azimuth, 112° 13′. No. 7, distant 8.2 feet; azimuth, 120° 43′.

[Latitude 44° 12′ 45.38″. Longitude 69° 09′ 05.33″.]

To station.	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Liberty	148 38 04.55	328 31 28.33	4.3823695
Liberty Church	148 55 10	....	4.36347
Frye	169 47 31.16	349 44 44.28	4.4738346
Harris	180 16 03.41	0 16 10.87	4.7015453
Patterson	203 26 52.65	23 30 54.80	4.2854389
Bald Rock	234 43 33	....	4.02164
Mount Desert	257 52 04.70	78 30 48.08	4.8772814

HARRIS, PENOBSCOT COUNTY.

A station of the United States Coast and Geodetic Survey on highest point of largest hill in town of Dixmont, 1.5 miles east of Dixmont.

Station mark: A masonry column 10 feet high and 7 feet in diameter, with a hole in center 2 feet in diameter.

Reference marks: Drill hole in rock N. 2° 38′ E., distant 74 feet; drill hole in rock S. 80° 50′ E., distant 17.3 feet; drill hole in rock S. 72° 50′, distant 69.4 feet.

[Latitude 44° 39′ 54.87″. Longitude 69° 08′ 54.67″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ragged	0 16 10.87	180 16 03.41	4.7015453
Frye	14 42 41.97	194 39 46.94	4.3365735
Liberty	23 17 52.10	203 11 06.80	4.5097166
Patterson	347 08 23.11	167 12 18.77	4.5241926
Charleston	191 51 30.15	11 57 05.28	4.7034506
Carmel	229 05 12.30	49 12 44.67	4.2719702
Greenfield	230 15 31.96	50 44 54.33	4.8516641
Bangor	241 11 48.28	61 27 13.31	4.5179486
Eddington	243 33 32.38	63 53 55.23	4.6297717
Peaked Mountain	251 11 30.06	71 40 23.99	4.7570784
Mount Saunders	270 50 43.86	91 13 37.14	4.6339557

BALD ROCK, WALDO COUNTY.

(Not occupied.)

A high, bald knob in town of Lincolnville, 3 miles south of Frenchs Beach.

Station mark: An iron ringbolt set horizontally in south face of highest projection of rock.

[Latitude 44° 16′ 01.86″. Longitude 69° 02′ 38.45″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ragged	....	....	4.02164
Liberty	....	....	4.40902
Frye	....	....	4.43219
Patterson	....	....	4.06694

CHURCH AT HEAD OF TIDE, WALDO COUNTY.

(Not occupied.)

Station mark: Center of spire.

[Latitude 44° 26′ 58.25″. Longitude 69° 03′ 20.84″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Patterson			3.93591
Frye			4.12162

FRYE, WALDO COUNTY.

Situated on high, bare hill in town of Montville.

Station mark: A bronze triangulation tablet cemented in solid rock.

Reference mark: Six iron ringbolts at foot of quadripod legs. No. 1, distant 4.2 feet; azimuth, 252° 28′. No. 2, distant 8.5 feet; azimuth, 266° 10′. No. 3, distant 7.8 feet; azimuth, 359° 39′. No. 4, distant 5.8 feet; azimuth, 75° 09′. No. 5, distant 4.1 feet; azimuth, 155° 56′. No. 6, distant 4.5 feet; azimuth, 178° 53″.

[Latitude 44° 28′ 34.66″. Longitude 69° 13′ 04.08″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Liberty	39 50 28.03	219 46 38.03	4.0549328
Harris	194 39 46.94	14 42 41.97	4.3365735
Patterson	311 47 57.89	131 54 47.74	4.2402895
Bald Rock			4.43219
Ragged	349 44 44.28	169 47 31.16	4.4738346

LIBERTY, WALDO COUNTY.

Situated on bare hill, locally known as Haystack, in town of Liberty. Village of Liberty is at foot of hill.

Station mark: A bronze triangulation tablet cemented in solid rock.

Reference marks: Four iron ringbolts at foot of quadripod legs. No. 1, distant 7.4 feet; azimuth, 137° 20′. No. 2, distant 7.3 feet; azimuth, 238° 34′. No. 3, distant 7 feet; azimuth, 323° 04′. No. 4, distant 6.8 feet; azimuth, 59° 41′.

[Latitude 44° 23′ 52.23″. Longitude 69° 18′ 32.60″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Harris	203 11 06.80	23 17 52.10	4.5097166
Frye	219 46 38.03	39 50 28.03	4.0549328
Patterson	278 01 43.57	98 12 22.92	4.3104300
Bald Rock			4.40902
Ragged	328 31 28.33	148 38 04.55	4.3823695

LIBERTY CHURCH, WALDO COUNTY.

(Not occupied.)

Station mark: Center of spire on church in village of Liberty.

[Latitude 44° 23′ 25.80″. Longitude 69° 18′ 03.93″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Patterson			4.29466
Ragged			4.36347

PATTERSON, WALDO COUNTY.

Situated on a bare hill about 4 miles southwest of Belfast.

Station mark: A bronze tablet cemented in solid rock.

Reference marks: Four iron ringbolts at foot of quadripod legs. No. 1, distant 6.9 feet; azimuth, 210° 06′. No. 2, distant 6.4 feet; azimuth, 297° 35′. No. 3, distant 5.3 feet; azimuth, 34° 03′. No. 4, distant 6.4 feet; azimuth, 132° 47′.

[Latitude 44° 22′ 18.73″. Longitude 69° 03′ 18.56″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ragged	23 30 54.80	203 26 52.65	4.2854389
Liberty	98 12 22.92	278 01 43.57	4.3104300
Frye	131 54 47.74	311 47 57.89	4.2402895
Harris	167 12 18.77	347 08 23.11	4.5241926
Bald Rock			4.06694

MARYLAND.

PRIMARY TRAVERSE.

CARROLL, FREDERICK, HOWARD, AND MONTGOMERY COUNTIES.

MONOCACY, RIDGEVILLE, ROCKVILLE, AND SENECA QUADRANGLES.

The following geographic positions on the United States standard datum were obtained from primary traverse run in 1904 by Mr. C. B. Kendall. The first line starts from the west tower of the Lutheran Church at Frederick, Md., a triangulation station of the United States Coast and Geodetic Survey, and follows highways north to the edge of the quadrangle, and thence east through Libertytown, Unionville, and Winfield, and connects with line run in 1902 by Mr. E. L. McNair, 1¼ miles north of Bennett post-office at the junction of the Washington and Liberty roads. Line No. 2 starts at Libertytown and follows highways south through New Market to Brink post-office; thence west to the Chesapeake and Ohio Canal at the mouth of the Monocacy River; thence along the canal to Noland Ferry and north to Frederick. Line No. 3 starts at Brink and follows highways east through Goshen and Laytonsville to Glenelg, where it connects with point located in 1902 by Mr. E. L. McNair and in 1903 by Mr. C. B. Kendall. Line No. 4 starts at Brink and follows highways south through Gaithersburg and Travilah to the Chesapeake and Ohio Canal. Line No. 5 starts from the Monocacy River aqueduct of the Chesapeake and Ohio Canal and follows the canal south and east, connecting with line No. 4, and thence east along highways through Potomac and connects with line run in 1903 by Mr. C. B. Kendall 1 mile west of Burnt Mills.

FREDERICK COUNTY, MONOCACY QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Frederick, west tower of Lutheran Church	39 24 55.3	77 24 34.8
Frederick, Seventh and Market streets, junction of, 45 feet west to fountain, 55 feet northeast to brick corner post of yard	39 25 21.7	77 24 34.9
Wannon's mill, junction of pikes, 50 feet northeast to mail box, 35 feet west to telephone pole at fence corner	39 26 37.4	77 23 41.8
Harmony Grove station, 200 feet southwest of, Baltimore and Ohio Railroad and pike crossing	39 27 10.4	77 23 58.1
Toll gate, 3 corners at, 12 feet north to southeast corner of porch	39 28 03.6	77 24 09.3
Three corners, 25 feet northeast to fence corner post, 25 feet southeast to corner stone fence	39 28 54.3	77 23 45.8
Harrisville, forks of road	39 29 51.6	77 24 07.3
Three corners, 35 feet southeast to blazed locust tree, 25 feet west to pole fence	39 30 32.3	77 23 53.6

FREDERICK COUNTY, MONOCACY QUADRANGLE—continued.

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Monocacy River, on north end of center pier of Devilbiss Bridge, cemented in bed rock in northwest corner of span of bridge, bronze tablet stamped "Prim. Trav. Sta. No. 54"	° ′ ″ 39 30 26.6	° ′ ″ 77 22 37.8
Walkersville, 1 mile northwest of, Pennsylvania Railroad crossing	39 29 45.8	77 20 45.2
Walkersville, 1 mile east of, at cemetery, 4 corners, 60 feet northeast to corner of cemetery fence, 25 feet southeast to fence corner	39 29 33.9	77 19 57.6
Forks of road	39 29 33.4	77 19 06.3
Daysville, forks of road ¾ mile west of, 20 feet southwest to fence corner post, 15 feet north to arrow on fence	39 29 15.6	77 17 39.7
Red Brick Church, 3 corners 150 feet west of	39 29 14.3	77 16 47.5
Libertytown, forks of road at west edge of, 40 feet southwest to telephone pole, 60 feet southeast to northwest corner of house	39 29 04.2	77 15 03.6
New London, 4 corners 1¼ miles north of, near summit, 20 feet northeast to mail box, 25 feet northwest to mail box	39 26 10.2	77 15 12.6
New London, northwest corner of iron bridge over Bens Branch	39 25 13.6	77 15 16.7
Sand Hill schoolhouse, forks of road, 25 feet southwest to fence, 25 feet northwest to fence	39 24 40.8	77 15 36.3
Four corners, 25 feet northwest to tree at fence corner, 20 feet northeast to large rock	39 24 13.9	77 15 33.4
New Market, cross pikes at, 45 feet southeast to northwest corner yellow dwelling, 40 feet southwest to bay window	39 22 58.6	77 16 11.5
South end of coping stone to west abutment of Baltimore and Ohio Railroad girder span over public road, bronze tablet stamped "Prim. Trav. Sta. No. 25"	39 22 20.8	77 16 20.9
Three corners, 30 feet southeast to blazed cherry tree, 15 feet northwest to telephone pole	39 21 36.6	77 16 10.5
Forks of road, 10 feet west to mark on fence	39 20 46.3	77 16 14.5
Fountain Mills, forks of road, 40 feet east to store corner, 40 feet north to locust tree at fence	39 20 21.2	77 16 13.6
Browningsville, 3 corners at top of hill 1¾ miles northwest of; 30 feet south to telephone pole, 30 feet southeast to blazed tree	39 19 13.6	77 15 38.8
Baltimore and Ohio girder bridge, center of	39 15 01.6	77 28 55.1
Licksville, 4 corners 0.5 miles west of, 20 feet northwest to mark on fence post, 35 feet southeast to telephone pole	39 15 34.5	77 28 38.8
Three corners, 25 feet west to mark on fence, 25 feet northeast to corner fence gate	39 17 11.9	77 28 07.9
Adamstown, 4 corners 1 mile northeast of, 25 feet northeast to fence corner, 25 feet northwest to fence corner	39 18 44.6	77 27 38.8
Adamstown, Baltimore and Ohio Railroad crossing 2 miles northeast of, center between tracks	39 19 32.9	77 27 23.9

FREDERICK COUNTY, MONOCACY QUADRANGLE—continued.

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Four corners, 350 feet north of, cemented in southwest corner of brick dwelling of Mr. Robert Graham, aluminum tablet stamped "Prim. Trav. Sta. No. 490"	39 19 54.3	77 27 16.7
Forks of road, small grassplot in angle of, 25 feet east to mark on fence, 20 feet west to locust tree	39 21 38.2	77 26 37.5
Old Mill, 3 corners 300 feet north of, 25 feet south to bridge, 50 feet northeast to apple tree	39 22 27.3	77 26 48.5
Frederick, 1 mile west of, at pike junction, 45 feet southwest to corner wire fence, 25 feet southeast to mark on plank fence	39 24 17.0	77 26 09.5
Frederick, junction of National and Jefferson pikes at west edge of, 25 feet northwest to telephone pole, 25 feet south to telephone pole	39 24 40.6	77 25 20.3

MONTGOMERY COUNTY, ROCKVILLE QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Cedar Grove, grass plot at forks of road 100 feet west of Upper Seneca Baptist Church	39 14 26.7	77 14 05.1
Brink post-office, 4 corners, 27 feet west to nail in persimmon tree, 27 feet north to nail in fence post	39 12 35.9	77 14 24.4
Brink post-office, cemented in rock foundation at northeast corner of dwelling of W. T. Dowden, aluminum tablet stamped "Prim. Tra. Sta. No. 341"	39 12 35.2	77 14 25.1
Neelsville, large spreading tree at forks of road	39 12 49.7	77 14 57.2
Forks of road, 30 feet northwest to chestnut tree, 35 feet southwest to oak tree	39 12 25.2	77 13 08.0
Seneca Creek, forks of road 80 feet southeast of center of bridge over, 45 feet southeast to mark on fence corner	39 12 03.6	77 12 14.2
Goshen, forks of road, 20 feet west to fence, 30 feet southeast to stump	39 12 13.1	77 11 14.9
Laytonsville, 4 corners, 1½ miles west of, 40 feet southwest to locust tree, 40 feet northeast to mark on fence corner	39 12 29.6	77 10 10.3
Laytonsville, cemented in north wall of brick dwelling of Mr. Ed. O. Brown on southeast corner of Baltimore and Washington streets, aluminum tablet stamped "Prim. Trav. Sta. No. 46"	39 12 42.6	77 08 34.8
Hawlings River, center of bridge over	39 13 03.5	77 06 21.5
Forks of road, at whitewashed house, 25 feet north to yard fence, 35 feet south to fence	39 13 18.5	77 05 09.2
Unity, 4 corners, ½ mile west of, 30 feet northwest to stump, 25 feet southeast to corner of plank fence	39 13 36.7	77 04 34.9
Patuxent River, center of bridge over	39 14 58.6	77 03 58.9

MONTGOMERY COUNTY, ROCKVILLE QUADRANGLE—continued.

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Brink post-office, 3 corners, 1 mile south of, at Neelsville Presbyterian Church, 50 feet east to wire fence, 40 feet northwest to yard corner	39 11 43.7	77 14 39.4
Middlebrook, 4 corners, 60 feet northwest to store corner, 45 feet southwest to stone at fence corner	39 10 42.6	77 14 18.8
Seneca Creek, center of bridge over	39 10 01.2	77 13 37.4
Three corners, 40 feet east to tree at fence corner, 45 feet northeast to fence corner	39 09 28.1	77 13 04.7
Gaithersburg, cemented in north wall at northwest corner of brick store of Mr. R. A. Young at junction of Frederick avenue and Chestnut street, aluminum tablet stamped "Prim. Trav. Sta. No. 24"	39 08 38.1	77 12 06.1
Gaithersburg, Frederick avenue crossing, Baltimore and Ohio Railroad, 55 feet east to telegraph office, 40 feet northwest to crossing sign	39 08 29.8	77 11 55.3
Three corners	39 07 30.3	77 12 48.8
Three corners, 30 feet northeast to cedar tree, 35 feet southeast to fence corner	39 06 55.7	77 12 58.8
Three corners, at signboard, 35 feet north to signboard, 15 feet south to telephone pole	39 06 12.3	77 13 26.0
Three corners, 40 feet north to fence corner, 40 feet southwest to fence painted	39 05 01.9	77 14 54.9
Grimes Lock No. 21, 3 corners, ½ mile north of, 29 feet southeast to nail in fence post, 36 feet southwest to nail in fence post	39 02 07.6	77 14 26.2
Grimes Lock No. 21, cemented in coping stone of west wing wall to south end of, aluminum tablet stamped "Prim. Trav. Sta. No. 179"	39 01 53.2	77 14 36.7
Forks of road, 25 feet south to mark on fence	39 01 54.3	77 13 59.4
Three corners, 35 feet south to corner fence, 30 feet east to fence	39 01 38.0	77 13 13.5
Potomac, 4 corners, 75 feet northeast to southwest corner post-office, 50 feet east to corner Jno. Stones store	39 01 06.1	77 12 33.1
Three corners, 30 feet south to wire fence, 30 feet northwest to fence corner	39 00 08.4	77 10 51.8
Cabin John Creek, crossroads 125 feet west of	38 59 49.4	77 10 11.3
Emeryn crossroads, 40 feet southeast to corner small dwelling, 25 feet south to stable corner	38 59 33.4	77 09 41.3
Cabin John Bridge, forks of road 1 mile northeast of, 25 feet east to wire fence corner, 50 feet north to telephone pole	38 59 00.9	77 08 15.3
Forks of road, 25 feet southeast to telephone pole, 25 feet north to forked cherry tree	38 59 24.6	77 07 17.8
Bethesda street car station, 3 corners, ¾ mile south of, 25 feet east to car track, 50 feet southwest to store corner	39 00 00.9	77 06 35.6
Georgetown pike, 3 corners at	39 00 23.7	77 05 52.0
Bethesda street car station, cemented in middle stone of west wall of culvert near Rock Creek on Georgetown pike 0.8 miles east of, aluminum tablet stamped "Prim. *Trav. Sta. No. 302*"	39 00 21.9	77 05 52.1

MONTGOMERY COUNTY, ROCKVILLE QUADRANGLE—continued,

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Forks of road, 60 feet northeast to telephone pole, 50 feet east to telephone pole	38 59 46.3	77 05 48.7
Forest Glen, street car crossing 1 mile south of	38 59 59.9	77 04 37.8
Overhead bridge	38 59 52.1	77 03 25.9
Triangle, junction Brookville pike and road to Forest Glen, 45 feet southwest to cedar tree at gate, 25 feet northwest to telephone pole	39 00 34.5	77 02 27.5
Burnt Mills, 4 corners, 1 mile west of, junction Coleville pike and Blanchard and Wheaton road, 33 feet west to real estate office	39 01 13.1	77 00 47.1
Burnt Mills, 4 corners, 1 mile west of, cemented in north stone of gatepost to entrance to farm of Mr. Kolk, aluminum tablet stamped "Prim. Trav. Sta. No. 361".	39 01 13.2	77 00 46.3

MONTGOMERY COUNTY, SENECA QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Clarksburg, 3 corners at, 30 feet northwest to corner post, 50 feet northeast to stone at corner iron fence	39 14 19.6	77 16 46.7
Clarksburg, 3 corners 1 mile northwest of	39 14 49.4	77 17 47.5
Thompsons Corners, 400 feet west of store, 40 feet northwest to blazed tree, 30 feet southwest to post of yard fence	39 14 33.7	77 19 20.1
Comus, cemented in large stone in northwest corner of intersection of crossroads, 60 feet northeast of northeast corner of post-office and 10 feet east of southeast corner of fence of W. A. Maxwell's house, aluminum tablet stamped "Prim. Trav. Sta. No. 384"	39 14 48.9	77 21 00.3
Forks of road, 25 feet east to front-yard fence, 35 feet west to oak tree	39 14 11.5	77 21 36.7
Barnesville, 3 corners 150 feet west of schoolhouse in east edge of. 30 feet northeast to oak tree	39 13 14.0	77 22 32.3
Little Monocacy River, center of iron bridge over	39 13 36.7	77 24 20.7
Dickerson, center of bridge over Baltimore and Ohio Railroad, 1 mile northwest of	39 13 25.0	77 26 27.7

MONTGOMERY COUNTY, SENECA QUADRANGLE—continued.

Geographic positions along the Chesapeake and Ohio Canal between Monocacy River and Sandy Run.

Station.	Latitude.	Longitude.
Monocacy aqueduct, cemented in coping of east wing wall of south abutment, aluminum tablet stamped "Prim. Trav. Sta. No. 442"	° ′ ″ 39 13 23.1	° ′ ″ 77 27 06.5
Culvert	39 14 36.9	77 28 30.8
Tower gate of Monocacy Lock No. 27	39 12 56.8	77 27 29.7
Lock No. 26, towpath opposite upper gate	39 11 26.2	77 28 17.1
Sawmill road, towpath opposite	39 10 25.7	77 30 00.0
White's ferry bridge, towpath under center of	39 09 16.2	77 31 02.5
D. C. Winbrener Landing No. 2, towpath opposite	39 07 08.6	77 29 56.4
Edwards Ferry, Lock No. 25, cemented in top coping stone of west wing wall to south gate of, aluminum tablet stamped "Prim. Trav. Sta. No. 88"	39 06 11.2	77 28 20.3
Road north at two dwellings and red barn, towpath opposite	39 04 41.4	77 26 23.3
Sycamore Landing, towpath opposite center of warehouse	39 04 25.8	77 25 09.0
Seneca Creek aqueduct, cemented in south wing wall of west abutment of, aluminum tablet stamped "Prim. Trav. Sta. No. 127"	39 04 05.3	77 20 28.5
Rushville, cross mark in coping stone of upper gate at south end of Lock No. 23	39 03 59.7	77 19 43.0
Pennfields, Lock No. 22, towpath opposite upper gate	39 03 15.2	77 17 21.5
Wood road, towpath opposite	39 02 43.1	77 16 25.2

Geographic positions along highways.

Station.	Latitude	Longitude.
Travilah, 4 corners at, 35 feet southeast to stone porch, 25 feet northeast to front-yard fence	° ′ ″ 39 04 08.7	° ′ ″ 77 15 48.6
Forks of road, small grass plat at, 275 feet west of iron bridge over Sandy Branch	39 02 42.5	77 15 40.9

CARROLL, FREDERICK, AND HOWARD COUNTIES, RIDGEVILLE QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Libertytown, in face of south wall, 2 feet west of front entrance to public school No. 1, Liberty District No. 8, aluminum tablet stamped "Prim. Trav. Sta. No. 123 A"	° ′ ″ 39 29 05.9	° ′ ″ 77 14 40.7
Libertytown, Main and Church streets	39 29 06.4	77 14 26.3
Albaugh's mill, forks of road just south of, 35 feet east to oak tree, 65 feet to oak tree at large rock	39 28 13.5	77 14 55.5
Public school, 3 corners to west of, 25 feet northwest to mail box, 60 feet south to elm tree	39 27 24.2	77 14 54.9

CARROLL, FREDERICK, AND HOWARD COUNTIES, RIDGEVILLE QUADRANGLE—continued.

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Bethesda Methodist Episcopal Church, forks of road 150 feet south of, 30 feet northwest to pump, 35 feet southeast to oak tree	39 18 47.8	77 14 48.6
Browningsville, 3 corners ¾ mile southeast of, 25 feet east to fence, 25 feet northwest to fence	39 18 05.8	77 14 09.8
Forks of road, 25 feet southeast to double chestnut tree, 30 feet west to mark on fence	39 17 11.8	77 13 17.4
Kings Valley post-office, 3 corners; 35 feet southeast to front step of post-office, 25 feet west to blazed cherry tree	39 16 07.5	77 14 08.0
Cedar Heights, crossroads, 22 feet south to north corner of small house, 24 feet northwest to dead cherry tree	39 15 11.2	77 13 47.0
Three corners, 20 feet south to telephone pole, 45 feet northeast to maple tree	39 28 45.5	77 12 27.0
Unionville, forks of road at, 60 feet south to creek, 35 feet west to scales	39 28 29.2	77 11 08.5
Forks of roads, mail box in center of diamond at, 70 feet south to large oak tree, 45 feet northwest to blazed maple tree	39 28 06.9	77 10 08.0
Schoolhouse, 3 corners 400 feet west of, 30 feet south to fence corner, 15 feet north to large rock	39 28 04.4	77 08 43.7
Frederick-Carroll county line, 4 corners at, 45 feet northwest to fence corner, 35 feet southwest to fence corner	39 27 46.1	77 07 08.0
"Four Corners schoolhouse," cemented in south wall at southeast corner of, aluminum tablet stamped "Prin. Trav. Sta. No. 46"	39 27 45.7	77 06 49.0
Franklinville, 1,000 feet east of store; 3 corners	39 27 33.2	77 05 58.3
Taylorsville, 4 corners at, 60 feet southwest to northeast corner of store, 35 feet southeast to northwest corner of house	39 27 28.5	77 05 13.2
Winfield, 4 corners at, 15 feet southwest to telephone pole, 50 feet southeast to northwest corner store	39 26 50.9	77 03 20.4
Piney Run, bridge over	39 26 23.4	77 02 05.3
Berrett post-office, 4 corners 1¼ miles north of, 33 feet south to nail in telephone pole, 41 feet southwest to nail in tree	39 25 46.2	77 00 30.8
Berrett post-office, 1¼ miles north of, cemented in brick foundation under southeast corner of store of Messrs. A. and P. D. Dorsey, aluminum tablet stamped "Prim. Trav. Sta. No. 15"	39 25 46.2	77 00 29.7
Roxburg Mills, 4 corners ½ mile south of	39 15 04.8	77 03 17.7
West end of bridge over small stream	39 15 21.3	77 02 44.1
Glenelg, forks of road ¾ mile west of, 35 feet southeast to fence, 20 feet north to fence	39 15 19.8	77 01 02.5
Glenelg, cemented in south wall at southeast corner of Providence Methodist Episcopal Church, aluminum tablet stamped "Prim. Trav. Sta. No. 131"	39 15 37.2	77 00 37.1

ANNE ARUNDEL, CALVERT, AND PRINCE GEORGE COUNTIES.

OWENSVILLE QUADRANGLE.

The following geographic positions were determined by primary traverse run by Mr. C. B. Kendall, field assistant, in the summer of 1904. The line begins with adjusted position of north end of highway bridge over the Philadelphia, Baltimore and Washington Railroad at Bowie, established by primary traverse by Mr. C. B. Kendall in 1903, and follows the Popes Creek branch of the Pennsylvania Railroad to Upper Marlboro, thence along the Chesapeake Beach Railway to Chaney station. From Chaney station the line follows highways east and is tied to the position of the old Fairhaven wharf as given on the Coast and Geodetic Survey Chart No. 135.

Geographic positions along the Popes Creek branch of the Pennsylvania Railroad between Bowie and Upper Marlboro.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Bowie, east edge of road, 25 feet north of north end of bridge over Philadelphia, Baltimore and Washington Railroad	39 00 29.4	76 46 44.8
Bowie, the Imperial Hotel, in brick foundation at southwest corner of; aluminum tablet stamped "Prim. Trav. Sta. No. 3 (A)"	39 00 24.9	76 46 47.8
Bowie, 1.1 miles southeast of, center of track at road crossing	38 59 38.1	76 46 29.9
Collington station, 400 feet north of, center of track at road crossing	38 58 12.7	76 45 30.8
Trestle, waterway No. 4, overhead crossing	38 57 28.6	76 45 11.3
Mulliken station, 300 feet north of, center of track at road crossing	38 55 31.2	76 44 35.9
Halls station, 350 feet north of, 120 feet northwest of crossing, at southeast corner of post-office and store of H. C. Hopkins; iron bench-mark post stamped "Prim. Trav. Sta. No. 22 (A)"	38 54 09.8	76 44 09.4
Leeland station, center of road crossing	38 52 18.7	76 44 53.3
Hill station, center of road crossing	38 50 57.4	76 45 02.4
Marlboro station, 700 feet north of, center of track at south end of road crossing	38 49 15.0	76 44 39.2
Upper Marlboro, Prince George County court-house, in northwest corner of stone to porch; aluminum tablet stamped "Prim. Trav. Sta. No. 54"	38 49 00.0	76 45 02.4

Geographic positions along Chesapeake Beach Railroad between Marlboro and Chaney.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Marlboro, Chesapeake Beach Railroad station, 150 feet south of, center of track at road crossing	38 48 47.6	76 45 30.7
Marlboro, 1.2 miles southeast of, crossing of Pennsylvania and Chesapeake Beach railroads	38 48 07.0	76 44 40.0
Mount Calvert station, center of main track opposite	38 46 56.9	76 43 12.4
Patuxent River, 0.9 mile east of, center of track at road crossing	38 46 53.4	76 41 56.6
Pindell station, 750 feet east of, center of track under overhead highway bridge	38 46 29.3	76 40 52.5
Lyons Creek station, at corner of wire fence 100 feet west of road crossing and 50 feet north of center of main track; bench-mark post stamped "Prim. Trav. Sta. No. 73 (A)"	38 45 56.3	76 39 37.8
Lyons Creek station, 0.5 mile east of, trestle, center of track over public road	38 45 35.8	76 39 13.3
Chaney station, 500 feet east of, north end of highway bridge over railroad	38 44 55.3	76 38 23.0

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Jewell post-office, road forks at, 35 feet west to rail fence, 55 feet south to rail fence	38 45 18.7	76 37 06.7
Gravel Hill, road forks west and southwest, at top of hill	38 45 09.4	76 35 32.9
Old Fairhaven wharf, 1.2 miles west of; four corners, 35 feet north to large oak	38 45 16.4	76 34 44.7
Old Fairhaven wharf, 0.3 mile west of, on north edge of east and west road at junction with road leading south to new Fairhaven wharf; iron bench-mark post stamped "Prim. Trav. Sta. No. 137."	38 45 18.9	76 33 37.9
Old Fairhaven wharf, shore end of, at retaining wall	38 45 24.9	76 33 26.0

MINNESOTA.

PRIMARY TRAVERSE.

ANOKA, CARVER, HENNEPIN, AND WRIGHT COUNTIES.

ANOKA, LAKE MINNETONKA, AND LAKE SARAH QUADRANGLES.

The following geographic positions were determined by primary traverse by Mr. George T. Hawkins, topographer. Starting from United States Coast and Geodetic Survey astronomic station in the grounds of the University of Minnesota, at Minneapolis, a spur line was run in 1899 along the main line of the Northern Pacific Railway to Itasca station, and another spur line along the main line of the Canadian Pacific Railway to Hamel station. In 1904 circuits were completed by continuing these lines around the borders of the Lake Sarah and Minnetonka quadrangles.

ANOKA QUADRANGLE.

Geographic positions along the Northern Pacific Railway between Minneapolis and Itasca.

Station.	Latitude.	Longitude.
Minneapolis, astronomic pier in grounds of the State University on the small knoll about 300 feet south of the main stone building. Station mark: A brick pier with foundation 2 feet below surface	° ′ ″ 44 58 37.72	° ′ ″ 93 14 12.68
Great Northern and Northern Pacific railways crossing	45 01 35.5	93 16 01.6
Fridley station	45 05 05.9	93 16 09.9
T. 30 N., R. 24 W., quarter corner between secs. 13 and 14	45 05 09.4	93 16 02.6
Junction station	45 08 52.9	93 17 28.0
Coon Creek station	45 10 10.1	93 19 21.9
T. 31 N., R. 24 W., quarter corner between secs. 9 and 16	45 10 58.4	93 20 13.2
Anoka station (Great Northern)	45 12 18.8	93 22 33.5
T. 32 N., R. 25 W., corner secs. 27, 28, 33, and 34	45 13 31.4	93 26 55.5
T. 32 N., R. 25 W., corner secs. 19, 20, 29, and 30	45 14 27.7	93 29 23.9
Itasca station	45 14 59.0	93 30 15.1

Geographic positions along the Canadian Pacific Railway between Minneapolis and Hamel.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Great Northern and Canadian Pacific railways crossing	45 02 51.8	93 21 12.9
Crystal station	45 02 49.5	93 21 37.0
T. 118 N., R. 21 W., corner secs. 5, 6, 7, and 8	45 03 02.5	93 22 46.2
T. 118 N., Rs. 22 and 23 W., quarter corner between secs. 7 and 12	45 02 36.7	93 31 16.5
Hamel station	45 02 29.6	93 31 24.9

LAKE MINNETONKA QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Bench mark No. 2, crossroads 0.75 mile southeast of.	44 59 41.7	93 30 03.9
Crossroads..	44 58 14.9	93 30 04.3
Wayzata, crossroads near south end of bridge over railway east of	44 57 49.3	93 29 44.9
Narrows of Lake Minnetonka, T road north at south side of.	44 56 55.7	93 29 50.1
Crossroads..	44 56 29.9	93 30 05.1
Excelsior, 4 miles southeast of, 350 feet southwest of Mr. Charles Pichner's house, 250 feet south of T road south, on west side of north and south road, bench mark post set 38 inches in the ground stamped "Prim. Trav. Sta. No. 3, 1904".......................................	44 53 25.3	93 31 11.8
Chanhassen, T road south	44 51 41.9	93 31 49.0
Chanhassen, T road north 1.5 miles southwest of.........	44 50 26.6	93 32 25.0
Chanhassen, T road east 2.5 miles south of..............	44 49 31.8	93 32 07.8
Chaska, 3 miles east of, 15 feet north of St. Paul and St. Louis Railway, 100 feet west of crossing under railroad, bench-mark post set 44 inches in ground stamped "Prim. Trav. Sta. No. 4, 1904"	44 48 49.0	93 32 23.2

Geographic positions along the Minneapolis and St. Louis Railway near Chaska.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Railway crossing 0.5 mile west of bench mark No. 4.....	44 48 47.2	93 33 04.0
Chaska, 1.5 miles east of, railway crossing north and south	44 47 58.7	93 34 51.4
Chaska, crossing Chicago, Milwaukee and St. Paul Railway and Minneapolis and St. Louis Railway	44 47 19.2	93 36 01.1
Chaska, 40 feet west of station, 15 feet north of Minneapolis and St. Louis Railway, bench-mark post stamped "Prim. Trav. Sta. No. 5"............................	44 47 18.5	93 36 02.4

LAKE MINNETONKA QUADRANGLE—continued.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 115 N., Rs. 26 and 27 W., corner secs. 7, 18, 13, and 12.	44 46 34.1	93 38 29.7
T. 115 N., R. 27 W., corner secs. 10, 11, 14, and 15	44 46 33.4	93 40 59.0
T. 115 N., R. 27 W., corner secs. 8, 9, 16, and 17	44 46 31.9	93 43 26.9
T. 115 N., Rs. 27 and 28 W., corner secs. 7, 18, 13, and 12.	44 46 28.3	93 46 02.1
T. 115 N., Rs. 27 and 28 W., 275 feet north of corner secs. 7, 8, 13, and 12, on west side of north and south road, bench-mark post set 36 inches in ground, stamped "Prim. Trav. Sta. No. 6, 1904"	44 46 31.0	93 46 02.3
T. 116 N., R. 28 W., secs. 25, 26, 35, and 36, crossroads..	44 48 13.2	93 47 14.4
T. 116 N., R. 28 W., secs. 23, 24, 25, and 26, crossroads..	44 49 05.2	93 47 15.4
T. 116 N., R. 28 W., quarter corner between secs. 13 and 14, crossroads	44 50 23.2	93 47 16.2
Waconia, T street south, 0.25 mile east of Catholic Church and 1 block west of where street elbows north.	44 50 56.2	93 46 45.5
Waconia, T road east at schoolhouse 2 miles northeast of..	44 51 44.4	93 45 26.0
St. Bonifacius, 0.5 mile south of; on east side of north and south road at southwest corner of Thomas Kohman's yard, bench-mark post set 40 inches in ground, stamped "Prim. Trav. Sta. No. 7, 1904"	44 53 41.4	93 44 47.7
St. Bonifacius, T 117 N., R. 27 W., corner secs. 29, 30, 31, and 32	44 54 15.5	93 44 47.8
St. Bonifacius T. road east 0.75 mile north of	44 54 58.7	93 44 47.5
T. 117 N., R. 27 W., corner secs. 17, 18, 19, and 20	44 56 04.8	93 44 46.5
T. 117 N., R. 27 W., corner secs. 7, 8, 17, and 18........	44 56 57.2	93 44 46.8
T. 117 N., R. 27 W., corner secs. 5, 6, 7, and 8	44 57 48.2	93 44 47.2
Ts. 117 and 118 N., Rs. 27 and 28 W., corner secs. 1, 6, 31, and 36	44 58 35.6	93 46 00.0
T. 117 N., R. 27 W., quarter corner between secs. 30 and 31.	44 59 31.4	93 45 24.4

Geographic positions along the Great Northern Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Mapleplain, road crossing over railway 2 miles southeast of	44 59 34.4	93 37 10.2
Long Lake, road crossing over railway 1 mile west of....	44 59 07.0	93 35 36.4
Long Lake, road crossing east of station	44 59 06.4	93 34 22.4
Long Lake, road crossing 0.25 mile east of station	44 59 04.8	93 34 09.7
Long Lake-Wayzata, road crossing over, half way between	44 58 27.9	93 32 21.3

LAKE SARAH QUADRANGLE.

Geographic positions along the Great Northern Railway between Delano and Mapleplain.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Delano, 3 miles southeast of, 250 feet west of John Relay's house, in front yard of Charles Lagheen, on west side of north and south road, bench-mark post stamped "Prim. Trav. Sta. No. 8, 1904"	45 00 59.8	93 45 25.6
Delano, south end of bridge over Great Northern Railway, 2 miles east of	45 02 10.3	93 44 42.9
Comstock, railway crossing 2 miles northwest of	45 01 39.4	93 43 06.2
Comstock, railway crossing at	45 00 41.4	93 41 09.0
Mapleplain, railway crossing at	45 00 22.4	93 39 18.7
Mapleplain, road crossing under railway 0.75 mile east of	45 00 10.2	93 38 41.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Rockford, crossroads 3 miles southwest of	45 04 18.3	93 45 07.1
Rockford, "Soo" Railway crossing 1 mile south of	45 04 22.4	93 44 12.4
Rockford, north end of bridge over Crow River	45 05 17.2	93 43 57.8
Rockford, T road west 1.5 miles north of	45 06 41.3	93 44 13.7
Rockford, T road east 2.75 miles north of	45 07 20.5	93 44 13.9
Rockford, 3 miles north of, on west side of road at top of hill and on line with east and west fence on east side of road, bench-mark post stamped "Prim. Trav. Sta. No. 9, 1904"	45 07 41.4	93 44 13.9
T. 119 N., R. 27 W., quarter corner between secs. 5 and 8	45 08 13.0	93 44 13.4
T. 120 N., R. 27 W., corner secs. 28, 29, 32, and 33	45 09 58.0	93 43 34.0
St. Michaels, three corners 3 miles west and 1 mile south of (road east and west and road southeast)	45 11 41.6	93 44 34.0
T. 120 N., R. 27 W., sec. 9, center of	45 13 00.9	93 42 53.8
T. 120 N., R. 27 W., quarter corner between secs. 4 and 9	45 13 26.9	93 42 53.2
T. 120 N., R. 27 W., north quarter corner sec. 4	45 14 16.6	93 42 52.1
T. 121 N., R. 27 W., 20 feet north of center of sec. 33, on north side of east and west road at T road south, 1 foot from corner of wire fence, bench-mark post stamped "Prim. Trav. Sta. No. 10, 1904"	45 14 42.4	93 42 50.8
T. 121 N., R. 27 W., quarter corner between secs. 33 and 34	45 14 42.2	93 42 12.4
T. 121 N., R. 27 W., quarter corner between secs. 34 and 35	45 14 42.2	93 40 59.6
St. Michaels station, T road south	45 14 16.4	93 39 12.0
T. 121 N., Rs. 26 and 27 W., sixteenth corner 0.75 mile north between secs. 31 and 36	45 14 55.3	93 38 32.4
St. Michaels station, 1.5 miles northeast of, on line between secs. 29 and 32, about 400 feet east of west corner of and near elbow in road, bench-mark post stamped "Prim. Trav. Sta. No. 11, 1904"	45 15 08.2	93 37 12.5

LAKE SARAH QUADRANGLE—continued.

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 121 N., R. 26 W., corner secs. 28, 29, 32, and 33	45 15 08.3	93 36 03.2
T. 121 N., R. 26 W., quarter corner between secs. 28 and 33.	45 15 08.4	93 35 26.2
Crossroads, 1.75 miles east of quarter corner between secs. 28 and 33	45 15 08.1	93 33 18.0
Dayton, 0.5 mile west of, on north side of road where it bends to northwest at top of hill, bench-mark post set 38 inches in the ground, stamped "Prim. Trav. Sta. No. 12, 1904"	45 14 39.2	93 31 39.2
Dayton, cross streets 600 feet north of Catholic Church	45 14 38.3	93 30 52.1
T. 120 N., R. 25 W., corner secs. 5, 6, 7, and 8	45 13 27.0	93 30 07.7
T. 120 N., R. 25 W., corner secs. 7, 8, 17, and 18	45 12 35.7	93 30 07.0
Schoolhouse, crossroads at	45 11 56.0	93 29 13.3
Anoka station, Great Northern Railway	45 12 18.8	93 22 33.5
Anoka, crossing Main street and Second avenue	45 11 52.0	93 23 19.0
T. 120 N., R. 25 W., quarter corner between secs. 22 and 23.	45 11 16.8	93 26 30.0
T. 120 N., R. 25 W., quarter corner between secs. 21 and 22.	45 11 16.4	93 27 41.7
T. 120 N., R. 25 W., at sixteenth corner 0.25 mile west of corner secs. 20, 21, 28, and 29, on north side of east and west road 400 feet west of T road north, bench-mark post stamped "Prim. Trav. Sta. No. 1, 1904"	45 10 51.9	93 29 16.7
Bench mark No. 1, 0.5 mile west of, elbow of road east and southeast	45 10 52.1	93 29 55.9
Great Northern Railway, crossroads 50 feet north of	45 09 21.7	93 29 47.0
T road east	45 08 42.9	93 29 47.6
Crossroads north and south with northwest and southeast.	45 07 37.8	93 30 05.5
T. 119 N., R. 25 W., secs. 5 and 8, sixteenth corner 0.25 mile from corner secs. 5, 6, 7, and 8	45 06 59.0	93 30 05.9
Crossroads	45 04 57.3	93 30 04.5
Church and schoolhouse, crossroads at	45 03 42.3	93 30 04.6
Hamel, crossing "Soo" Railway 1 mile east of	45 02 28.6	93 30 23.7
Hamel, crossing north and south road with road northwest and southeast, 2 miles southeast of	45 01 24.9	93 30 23.3
Gerdet Lake, 100 feet north of where north and south road turns to southeast, corner of wire fence bears S. 20° E., and is 30 feet distant, bench-mark post set 38 inches in ground, stamped "Prim. Trav. Sta. No. 2, 1904"	45 00 12.4	93 30 22.7

NEBRASKA-IOWA.

PRIMARY TRAVERSE.

OTOE AND CASS COUNTIES, NEBR.; FREMONT COUNTY, IOWA.

NEBRASKA CITY QUADRANGLE.

The following geographic positions were determined from primary traverse run by Mr. J. R. Ellis in 1905. The line starts from the Missouri River Commission triangulation station, Otoe, follows the Burlington Railway across Missouri River; thence north along Kansas City, Saint Joseph and Council Bluffs Railway to Percival, thence along highways to the Missouri River Commission triangulation station, Pugh. Again starting at Otoe triangulation station the line follows Missouri Pacific Railway to Peru, Nebr., thence along highways westward to Talmage and connects with adjusted position near there.

Another line starts from adjusted position near Dunbar, Nebr., follows highways north and east along the border of the quadrangle to Wyoming, thence southeast along Missouri Pacific Railway to Nebraska City and connects with adjusted position there.

Geographic positions along the Kansas City, Saint Joseph and Council Bluffs Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Otoe triangulation station	40 39 26.96	95 49 04.16
Burlington Bridge over Missouri River, west end of	40 40 30.1	95 50 12.3
Schoolhouse, east and west railway crossing, 400 feet east of	40 40 50.8	95 48 31.2
IOWA.		
Nebraska City Junction, 700 feet north of, at road crossing on main line of Burlington Railroad, just west of right of way fence on land of M. M. Payne, iron post stamped "Prim. Trav. Sta. No. 1, 1905"	40 40 18.4	95 45 33.2
Private road crossing at corn sheds	40 41 20.0	95 46 22.4
Section line road crossing north and south	40 42 33.0	95 47 21.7
East and west road crossing at mile post 154	40 43 43.6	95 48 19.1

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Percival, Iowa, east side of Burlington Railroad, at cattle guard, 600 feet north of depot and just off right of way, on land of George Crocker, iron post stamped "Prim. Trav. Sta. No. 2, 1905"	40 45 11.3	95 48 27.9
T road north at corner, secs. 20, 21, 28, 29, T. 69 N., R. 43 W., 36 feet south to corner of hedge, 25 feet north to west end of bridge	40 45 37.4	95 48 08.5
T. 69 N., R. 43 W., secs. 21, 22, 27, and 28, corner of, T road north	40 45 37.9	95 46 59.9
T. 69 N., R. 43 W., secs. 22, 23, 26, and 27, corner of, T road south	40 45 40.7	95 45 54.0
T. 69 N., R. 43 W., secs. 23, 24, 25, and 26, corner of	40 45 40.1	95 44 44.7
Pugh triangulation station	40 46 43.34	95 44 16.8

Geographic positions along the Missouri Pacific Railway.

Station.	Latitude.	Longitude.
NEBRASKA.		
Road crossing east and west at wagon bridge over Four Mile Creek	° ′ ″ 40 38 55.2	° ′ ″ 95 48 38.6
Road crossing east and west	40 37 36.9	95 47 57.9
Minesville station, road crossing at north end of siding	40 36 00.9	95 47 14.8
Spier, switch block at section house	40 35 07.2	95 46 50.6
Barney, Nebr., platform	40 32 58.4	95 45 57.1
Otoe-Nemaha county line, road crossing	40 31 32.0	95 45 04.8

Geographic positions along highways.

Station.	Latitude.	Longitude.
Tps. 6 and 7 N., R. 15 E., quarter corner between secs. 5 and 32, T road south	° ′ ″ 40 31 32.0	° ′ ″ 95 45 11.8
Private road crossing at windmill	40 30 40.8	95 44 34.9
Peru, Nebr., 400 feet northwest of station, in southeast corner of field of Sam Adams, iron post stamped "Prim. Trav. Sta. No. 3, 1905"	40 29 23.4	95 43 50.2
Road north across lowlands	40 29 47.2	95 45 10.5
Duck Creek, east end of bridge over	40 30 16.1	95 47 24.5
T. 6 N., R. 14 E., corner secs. 2, 3, 10, and 11, crossroads	40 30 39.8	95 49 10.0
T. 6 N., R. 14 E., corner secs. 3, 4, 9, and 10, crossroads	40 30 40.2	95 50 18.9
T. 6 N., R. 14 E., corner secs. 4, 5, 8, and 9, crossroads, 48 feet southwest, to corner cemetery fence	40 30 39.3	95 51 26.7
Schoolhouse, just outside of southwest corner of, at corner section, iron post stamped "Prim. Trav. Sta. No. 4, 1905"	40 30 39.5	95 52 34.3
T. 6 N., Rs. 13 and 14 E., corner secs. 1, 6, 7, and 12, crossroads	40 30 38.5	95 53 43.4
T. 6 N., R. 10 E., corner secs. 1, 2, 11, and 12, crossroads	40 30 39.1	95 54 52.0
T. 6 N., R. 13 E., corner secs. 3, 4, 9, and 10, T road east, 33 feet northeast to corner fence post, 62 feet northwest to cross on telephone pole	40 30 39.3	95 57 08.9
Tps. 6 and 7 N., R. 13 E., secs. 3, 4, 33, and 34, also line between Otoe and Nemaha counties	40 31 31.2	95 57 08.9
Tps. 6 and 7 N., R. 13 E., corner secs. 4. 5, 32, and 33, crossroads, 40 feet northeast to large cottonwood tree, 22 feet southeast to south end of small bridge	40 31 31.2	95 58 16.9
Center of bridge	40 31 31.0	95 59 22.2
Talmage, Nebr., 1 mile southeast of, in south corner of field of Henry Faranholtz, at county line road crossing Missouri Pacific Railroad, iron post bears S. 34° 00′ W. distant 68.8 feet, iron post stamped "Prim. Trav. Sta. No. 5, 1905"	40 31 31.2	96 00 23.7
Road crossing north and south; 515 feet south of this crossing is corner of Tps. 6 and 7 N., Rs. 12 and 13 E., secs. 1, 6, 31, and 36	40 31 36.0	96 00 30.6

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Section line road crossing east and west	40 32 23.2	96 01 28.1
T. 7 N., R. 12 E., corner secs. 13, 14, 23, and 24	40 34 07.6	96 01 39.7
T. 8 N., R. 13 E., sec. 18, on northwest corner of township, on land of Henry W. Kruse, iron post stamped "Prim. Trav. Sta. No. 6, 1905"	40 40 12.5	96 00 34.5
T. 8 N., R. 12 E., corner secs. 7, 8, 17, and 18, crossroads	40 40 12.7	95 59 26.5
T. 8 N., R. 12 E., corner secs. 5, 6, 7, and 8, crossroads	40 41 04.9	95 59 27.5
T. 8 N., R. 12 E., north corner secs. 5 and 6, T road south at, 49 feet southeast to mail box, 36 feet southwest to cross on corner of fence post	40 41 57.0	95 59 28.4
T. 9 N., R. 12 E., south corner secs. 31 and 32, T road north at	40 41 57.1	95 59 11.2
T. 9 N., R. 12 E., corner secs. 29, 30, 31, and 32, crossroads at, 33 feet northwest to mail box	40 42 49.3	95 59 11.1
T 9 N., R. 12 E., corner secs. 19, 20, 29, and 30	40 43 41.3	95 59 11.1
T. 9 N., R. 12 E., northwest corner sec. 20, in top of limestone 30 by 11 by 7 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 7, 1905"	40 44 33.3	95 59 10.7
T. 9 N., R. 12 E., corner secs. 16, 17, 20, and 21, T road north	40 44 33.7	95 58 02.3
T. 9 N., R. 12 E., quarter corner between secs. 15 and 22, crossroads	40 44 33.5	95 56 19.3
Wyoming, Nebr., in east part of orchard of O. C. West, iron post stamped "Prim. Trav. Sta. No. 8, 1905"	40 44 11.0	95 55 02.7

Geographic positions along the Missouri Pacific Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Wyoming, 0.75 mile south of; north and south road crossing	40 43 40.5	95 54 36.5
Road crossing east and west	40 42 48.2	95 53 40.7
Road crossing east and west, 0.5 mile south of milepost 438	40 41 56.2	95 52 30.6
Road crossing north and south	40 41 05.5	95 51 12.1

NEW HAMPSHIRE AND VERMONT.

TRIANGULATION STATIONS.

MERRIMAC AND SULLIVAN COUNTIES, N. H.; WINDSOR COUNTY, VT.

SUNAPEE LAKE QUADRANGLE.

During the summer of 1904 control for the Sunapee Lake quadrangle was obtained from triangulation by Mr. E. L. McNair, topographer. The work was based upon the United States Coast and Geodetic Survey positions of Ascutney and Croydon. Four new stations were occupied and six secondary points cut in. Positions are given on United States standard datum.

NEW LONDON BAPTIST CHURCH, MERRIMAC COUNTY, N. H.

(Not occupied.)

Station mark: Center of church spire.

[Latitude 43° 24′ 45.6″. Longitude 71° 58′ 50.1″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Croydon			4.31899
Graves			4.34882

SUNAPEE, MERRIMAC COUNTY, N. H.

Situated about 2 miles south of Mount Sunapee station, on the most northerly end of the Sunapee Range. Summit partly covered with small timber. Can be reached in about one hour from the home of Nathan S. Johnson.

Station mark: A bronze triangulation tablet cemented in solid rock.

Reference marks: Three iron ringbolts at corners of signal, as follows: (1) Distant 7.2 feet; azimuth, 42° 57′. (2) distant 7.5 feet; azimuth, 133° 19′. (3) distant 7 feet; azimuth, 226° 48′.

[Latitude 43° 18′ 51.63″. Longitude 72° 04′ 29.37″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Lempster	28 07 23.7	208 04 46.4	4.0402614
Graves	67 47 27.2	247 42 47.8	3.9966933
Ascutney	115 44 06.3	295 28 32.8	4.5305363
Catholic Church in Newport			3.98731
Hoyt	186 23 31.9	6 24 36.4	4.2766559

CROYDON, SULLIVAN COUNTY, N. H.

A United States Coast and Geodetic Survey station about 8 miles north of Newport on a well-known mountain within the limits of the Blue Mountain Game Preserve, or Corbin Park.

Station mark: An iron bolt a little below surface of rock.

Reference marks: A bronze triangulation tablet cemented in solid rock 3 inches south of station mark. An iron bolt distant 7.3 feet; azimuth, 136° 36′. An iron bolt distant 10 feet; azimuth, 222° 12′. An iron bolt distant 7.3 feet; azimuth, 307° 14′.

[Latitude 43° 28′ 55.01″. Longitude 72° 13′ 11.60″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ascutney	78 11 48.0	258 02 12.0	4.2838623
Hoyt	269 14 18.9	89 21 22.9	4.1412011
New London Baptist Church			4.31899
Sunapee	327 41 34.0	147 47 32.8	4.3428037
Lempster	346 50 39.2	166 54 00.4	4.46327
Graves	353 24 19.5	173 25 38.4	4.3527001

GRAVES, SULLIVAN COUNTY, N. H.

Situated on a bare rocky hill in town of Unity about 6 miles south of Newport. Land owned by B. Graves.

Station mark: A bronze triangulation tablet cemented in solid rock.

Reference marks: Four iron ringbolts at corners of signal as follows: (1) Distant 6.8 feet; azimuth, 243° 36′. (2) distant 6.8 feet; azimuth, 332° 16′. (3) distant 7.8 feet; azimuth, 63° 43′. (4) distant 6.5 feet; azimuth, 150° 32′.

[Latitude 43° 16′ 49.88″. Longitude 72° 11′ 16.86″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ascutney	130 46 24.8	310 35 31.4	4.4511148
Croydon	173 25 38.4	353 24 19.5	4.3527001
Hoyt	206 31 55.3	26 37 39.5	4.4016189
Sunapee	247 42 47.8	67 47 27.2	3.9966933
Lempster	325 47 24.3	145 49 26.4	3.8547810

HOYT, SULLIVAN COUNTY, N. H.

Situated about 1 mile south of West Springfield, on Hoyt Mountain.

Station mark: A bronze triangulation tablet cemented in solid rock.

Reference marks: Three iron ringbolts at corners of signal as follows: (1) Distant 6.6 feet; azimuth, 122° 08′; (2) distant 7 feet; azimuth, 218° 03′; (3) distant 7 feet; azimuth, 302° 25′.

[Latitude 43° 29′ 00.52″. Longitude 72° 02′ 55.70″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sunapee	6 24 36.4	186 23 31.9	4.2766559
Lempster	14 21 24.6	194 17 42.9	4.4680855
Graves	26 37 39.5	206 31 55.3	4.4016189
Croydon	89 21 22.9	269 14 18.9	4.1412011

LEMPSTER, SULLIVAN COUNTY, N. H.

Situated on the highest point of the Lempster range of mountains, in town of Lempster.

Station mark: A bronze triangulation tablet cemented in solid rock.

Reference marks: Iron ringbolts at the four corners of the signal.

[Latitude 43° 13′ 38.02″. Longitude 72° 08′ 18.54″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ascutney	133 49 33.6	313 36 38.2	4.5467712
Graves	145 49 26.4	325 47 24.3	3.8547810
Croydon	166 54 00.4	346 50 39.2	4.4632700
Hoyt	194 17 42.9	14 21 24.6	4.4680855
Sunapee	208 04 46.4	28 07 23.7	4.0402614

NEWPORT CATHOLIC CHURCH, SULLIVAN COUNTY, N. H.

(Not occupied.)

Station mark: Center of church spire.

[Latitude 43° 22′ 00.1″. Longitude 72° 10′ 14.6″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Graves	....	....	3.98570
Sunapee	....	....	3.98731

NEWPORT CONGREGATIONAL CHURCH, SULLIVAN COUNTY, N. H.

(Not occupied.)

Station mark: Center of church spire.

[Latitude 43° 21′ 39.2″. Longitude 72° 10′ 14.9″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Graves			3.95603
Croydon			4.14689

NEWPORT COURT-HOUSE, SULLIVAN COUNTY, N. H.

(Not occupied.)

Station mark: Center of tower on court-house.

[Latitude 43° 21′ 52.7″. Longitude 72° 10′ 23.8″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Graves			3.97404
Croydon			4.13257

NEWPORT METHODIST CHURCH, SULLIVAN COUNTY, N. H.

(Not occupied.)

Station mark: Center of church spire.

[Latitude 43° 21′ 56.7″. Longitude 72° 10′ 26.5″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Graves			3.97937
Croydon			4.12820

ASCUTNEY, WINDSOR COUNTY, VT.

A United States Coast and Geodetic Survey station on a well-known mountain about 3 miles southwest of Windsor village. There is an excellent path from house of Allen Dudley to the summit. Station is on north end of mountain about 30 feet northeast of stone house built in 1904.

Station mark: A bronze triangulation tablet cemented in solid rock in the position of Coast Survey bolt and covering bolt of the old State survey. A triangle chiseled in the rock surrounds the tablet.

[Latitude 43° 26′ 46.74″. Longitude 72° 27′ 08.48″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Croydon	258 02 12.0	78 11 48.0	4.2838623
Sunapee	295 28 32.8	115 44 06.3	4.5305363
Graves	310 35 31.4	130 46 24.8	4.4511148
Lempster	313 36 38.2	133 49 33.6	4.5467712

NEW YORK.

TRIANGULATION STATIONS.

HERKIMER, MADISON, ONEIDA, AND OTSEGO COUNTIES.

SANGERFIELD AND WINFIELD QUADRANGLES.

In July, 1904, Mr. E. L. McNair, topographer, controlled by triangulation the above-mentioned quadrangles by reoccupying Litchfield, Plainfield, and Tassel stations, from which he located five new points. Positions are given on United States standard datum.

ARMSTRONG, HERKIMER COUNTY.

(Not occupied.)

On a bare hill about 2 miles north of Plainfield Center.

Station mark: A lone elm tree.

[Latitude 42° 50′ 55.48″. Longitude 75° 09′ 36.31″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Plainfield		208 14 23	3.67382
Owen		95 44 20	3.69171

LITCHFIELD, HERKIMER COUNTY.

Situated in Litchfield Township 0.5 mile north of Jerusalem Church on a cultivated bare hill owned by H. Wheelock.

Station mark: A stone post 30 by 8 by 6 inches set 28 inches in the ground, in the center of the top of which is cemented a bronze triangulation tablet.

[Latitude 42° 59′ 05.65″. Longitude 75° 08′ 44.17″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Plainfield	10 03 14.58	190 01 32.16	4.2918677
Tassel	70 59 03.1	250 52 03.1	4.1696687
Schuyler	186 52 09.4	6 53 21.2	4.2975436
Owen	346 38 19.77	166 40 10.98	4.2054577

M'CARTY, HERKIMER COUNTY.

(Not occupied.)

On a bare hill about 2 miles south of Winfield.

Station mark: A pile of rock.

[Latitude 42° 52′ 07.91″. Longitude 75° 08′ 01.24″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Plainfield		214 28 34	3.88961
Owen		134 55 41	3.58656

BROOKFIELD, MADISON COUNTY.

On a bare hill in town of Brookfield, about 2 miles south of North Brookfield, on land owned by C. F. York. Station is 4 feet west of fence between lands of Joseph Ritz and C. F. York, and 34 feet north of corner between Joseph Ritz and Alonzo York.

Station mark: A marble post 20 by 6 by 6 inches set 19 inches in ground, resting on solid rock. In the top is cemented a bronze triangulation tablet.

Subsurface mark: A 1-inch drill hole, 3 inches deep, in which are placed 7 tenpenny wire nails.

Reference mark: Elm tree about 15 inches in diameter, true azimuth, 307°; distant 9.25 feet.

[Latitude 42° 49′ 36.51″. Longitude 75° 23′ 49.40″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Madison	150 56 44.9	330 54 38.8	3.93743
Tassel	207 13 05.99	27 16 22.61	4.1559903
Owen	265 18 47.35	85 30 53.86	4.3864292
Plainfield	275 39 26.87	95 47 59.87	4.2353386

MADISON, MADISON COUNTY.

On a bare hill in Madison Township about 5 miles southeast of Waterville, on land owned by M. T. M. Mason.

Station mark: An iron bench mark post set 27 inches in the ground, resting on solid rock.

Subsurface mark: A 1-inch hole, 1½ inches deep, in which are placed 4 twentypenny spikes.

Reference marks: (1) A drill hole 1 inch in diameter and 3 inches deep in surface bowlder beside north and south fence running over hill, true azimuth, 210° 12′; distant 22.85 feet; (2) a drill hole 1 inch in diameter, 3 inches deep in surface bowlder along same fence; true azimuth, 348° 39′; distant 119 feet

[Latitude 42° 53′ 41.75″. Longitude 75° 26′ 54.71.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Tassel	244 18 15.8	64 23 38.7	4.07671
Brookfield	330 54 38.8	150 56 44.9	3.93743

TASSEL, ONEIDA COUNTY.

A station of the United States Coast and Geodetic Survey and of the New York State Survey, in Marshall Township, 5 miles east of Waterville.

Station mark: A granite post 48 by 6 by 6 inches set 44 inches in the ground and marked "N. Y. S. S. 29."

[Latitude 42° 56′ 29.13″. Longitude 75° 19′ 00.48″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Brookfield	27 16 22.61	207 13 05.99	4.1559903
Madison	64 23 38.7	244 18 15.8	4.07671
Schuyler	213 34 46.8	33 42 59.6	4.4692854
Litchfield	250 52 03.1	70 59 03.1	4.1696687
Owen	301 17 51.88	121 26 42.52	4.3163701
Plainfield	323 46 06.78	143 51 23.75	4.2530268

OWEN, OTSEGO COUNTY.

On a prominent bare hill 5 miles west of Richfield Springs, on land of Robert J. Owen, who lives in New York City.

Station mark: A marble post 20 by 6 by 6 inches set 16 inches in the ground and resting on solid rock. In top is cemented a bronze triangulation tablet.

Subsurface mark: A 1-inch hole drilled 3 inches deep directly under station mark, with two nails placed in it.

Reference marks: (1) A drill hole 1 inch in diameter and 1 inch deep in surface bowlder, true azimuth, 37° 42′; distant 87.3 feet; (2) a drill hole 1 inch in diameter and 1 inch deep in surface bowlder, true azimuth, 102° 54′; distant 63 feet.

[Latitude 42° 50′ 39.60″. Longitude 75° 06′ 00.84″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Plainfield	62 48 24.17	242 44 50.86	3.9039243
Brookfield	85 30 53.86	265 18 47.35	4.3864292
Armstrong	95 44 20.00	....	3.69171
Tassel	121 26 42.52	301 17 51.88	4.3163701
McCarty	134 55 41.00	....	3.58656
Litchfield	166 40 10.98	346 38 19.77	4.2054577

PLAINFIELD, OTSEGO COUNTY.

On a bald ridge owned by J. J. Roberts in town of Plainfield, 1.5 miles south of Plainfield Center.

Station mark: A bluestone post 36 by 6 by 6 inches set 22 inches in the ground and resting on solid rock. In the center of top of post is cemented a bronze triangulation tablet.

[Latitude 42° 48′ 40.77″. Longitude 75° 11′ 14.64″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Brookfield	95 47 59.87	275 39 26.87	4.2363386
Tassel	143 51 23.75	323 46 06.78	4.2530268
Litchfield	190 01 32.16	10 03 14.58	4.2918677
Armstrong	208 14 23.00	....	3.67382
McCarty	214 28 34.00	....	3.88961
Owen	242 44 50.86	62 48 24.17	3.9039243

PRIMARY TRAVERSE.

ERIE COUNTY.

EDEN QUADRANGLE.

The following geographic positions were determined from primary traverse by Mr. E. L. McNair, topographer, in 1904. The line starts at Hamburg triangulation station, United States Lake Survey, follows highways eastward to Orchard Park, and is connected with a point at

that place located by primary traverse in 1903. The line then follows highways along the eastern, southern, and western borders of the quadrangle, and is tied to Sturgeon Point triangulation station, United States Lake Survey. Another line crosses the quadrangle from west to east, connecting with Shefflin and Richmond triangulation stations of the United States Geological Survey. Positions are given on the United States standard datum.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Hamburg triangulation station, United States Lake Survey, in Hamburg Township, about 7 miles south of Buffalo, 2 miles northeast of Hamburg Railway station and 0.7 mile northwest of Bay View Hotel, 50 feet from edge of bluff. Station mark: A stone post 30 by 6 by 6 inches set 28 inches in ground. Reference marks: A stone post S. 12° 14′ E., 18.13 meters distant. A stone post N. 64° 32′ E., 42.5 meters distant	° ′ ″ 42 46 50.49	° ′ ″ 78 51 30.88
Four corners	42 46 19.0	78 50 10.9
Big Tree Inn, 4 corners	42 46 18.4	78 49 26.9
Four corners	42 46 01.4	78 47 30.3
Four corners	42 45 54.8	78 46 40.2
Buffalo, Rochester and Pittsburg crossing	42 45 47.7	78 45 25.1
Orchard Park, 4 corners	42 46 02.2	78 44 39.0
Orchard Park, Briggs Bros.' brick store, aluminum bench-mark tablet stamped elevation "868 feet"	42 46 02.4	78 44 39.6
Orchard Park, 1 mile south of, 4 corners	42 45 03.0	78 44 53.3
Four corners	42 43 56.0	78 44 58.5
Big Gulf, center of bridge over	42 43 08.2	78 44 49.9
Four corners	42 41 45.5	78 44 50.2
Forks of road at foot of hill	42 40 11.8	78 45 14.9
Boston Center (Patchin post-office)	42 39 27.6	78 44 52.5
T corners, road west	42 38 40.1	78 44 26.5
Boston Corners (Boston post-office), in triangular grass plot between roads, iron post set 44 inches in ground and stamped "Prim. Trav. Sta. 61." Reference marks: To southeast corner of Mrs. Charles Demmerly's house, true azimuth 118°, distance 78.3 feet to northwest corner of Boston Hotel; azimuth 313° 19′, distance 130.5 feet. To northwest corner Iroquois Hotel, azimuth 329° 39′, distance 102.5 feet	42 37 43.1	78 44 17.8
Road north; 300 feet northwest of residence of Felix Cusline	42 37 02.8	78 45 26.2
Brigham's cheese factory, 4 corners 170 feet south of	42 36 33.1	78 46 10.7
Peffer (Frank); in road opposite mail box in front of house	42 35 27.4	78 46 21.5
Three corners, 200 feet south of house of William Geiger.	42 35 16.8	78 46 52.4
Nye (William); in road opposite house of	42 34 12.6	78 46 08.8
Woodwards Hollow, or Wyandale	42 33 18.7	78 45 58.2
Murdock (D. W.); road west at house of	42 32 13.8	78 45 41.0
Nichole, 4 corners	42 31 18.4	78 45 56.9

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Mortons, 4 corners	42 30 40.3	78 45 55.8
Mortons, 4 corners, 500 feet west of, iron bench-mark post set 42 inches in ground and stamped "Prim. Trav. Sta. 134." Reference marks: Corner of house of Mrs. Martha Schabehorn, azimuth 120° 13′, distance 106 feet. Corner of house of Mrs. Helen Briggs, azimuth 245° 20′, distance 77.6 feet. Corner of house of Mrs. Emily Sampson, azimuth 301° 34′, distance 151.1 feet	42 30 40.5	78 46 02.4
Forks of road	42 30 41.0	78 47 18.4
Four corners	42 30 41.0	78 48 39.9
Road north	42 30 39.7	78 49 41.5
Four corners, 0.5 mile east of house of H. T. Brown	42 30 38.6	78 50 40.6
Collins Center, 1 mile north of, 2 feet from northwest corner of porch of house of Mr. C. P. Naegle, iron bench mark post stamped "Prim. Trav. Sta."	42 30 36.8	78 51 46.7
Four corners	42 30 37.3	78 52 36.0
Forks of road	42 30 37.0	78 53 41.6
Four corners at Frank Sissens, on Quaker street	42 31 12.7	78 54 50.6
Lawton station, four corners 1 mile south of	42 31 10.7	78 56 05.2
Four corners, 260 feet east of Indian Reservation line	42 31 12.7	78 56 35.6
School, four corners	42 30 00.4	78 56 29.1
Versailles, 1 mile north of; four corners on Indian Reservation	42 31 57.5	78 59 11.2
Iroquois, Indian Orphan Asylum, in southeast corner of brick school, bronze triangulation tablet stamped "Prim. Trav. Sta."	42 32 19.1	78 59 51.3
Pierce's (S. J.) house, three corners at	42 32 37.1	79 01 07.3
Road east	42 33 49.9	79 01 05.4
Brant post-office, four corners	42 35 17.9	79 01 04.6
Sheflin, Jacob, four corners at house of	42 36 35.5	79 01 03.0
T corners, south, east, and west	42 37 27.5	79 01 02.8
White's (Paul) house, forks of road 1,000 feet south of	42 37 46.3	78 58 50.8
Dash (Alfred), T corners, road west, 600 feet east of house of	42 38 13.7	78 59 01.2
Mr. Gowans, T corners north, south, and west	42 38 29.2	78 58 19.5
Clark's (Sydney) house, four corners, school district No. 10	42 39 08.7	78 58 21.9
Derby post-office, four corners 775 feet east of	42 40 42.0	78 58 20.8
East Evans, four corners	42 40 59.4	79 00 55.2
Four corners	42 40 59.6	79 02 09.7
Sturgeon Point triangulation station, United States Lake Survey, in Evans Township at extreme end of Sturgeon Point, 3 miles northwest of Angola, 3 miles west of Derby, at east end of road leading from Derby to lake shore. Station mark: A stone post 36 by 6 by 6 inches set 32 inches in ground. Reference marks: A stone post N. 45° 52′ E., distance 32.75 meters. A stone post N. 75° 03′ E., distance 5.5 meters.	42 41 24.75	79 02 52.90

Geographic positions along highways between Sheflin triangulation station and New Oregon.

Station.	Latitude.	Longitude.
Sheflin triangulation station, in town of Evans, 2 miles southeast of Angola Railroad station, 250 feet north of Brant Line road, 0.25 mile east of north and south road, on highest ground in pasture owned by Jacob Sheflin. Station mark: A stone monument 48 by 6 by 6 inches set 44 inches in ground, having in center of top of post a copper bolt stamped "U. S. G. S. 459 N. Y."	° ′ ″ 42 36 38.21	° ′ ″ 79 00 30.25
Road south	42 36 33.6	78 59 17.7
Four corners	42 36 33.4	78 58 24.5
Road south	42 36 32.5	78 57 27.2
T corners at house of H. R. Hibbards	42 36 31.8	78 56 18.6
North Collins, 0.25 mile north of Erie Railway crossing	42 35 55.0	78 56 05.8
Four corners at farm of Mrs. Eunice Rogers	42 35 55.2	78 54 03.1
Taber Cheese Factory, four corners	42 35 15.3	78 54 03.5
Richmond triangulation station, in North Collins, 1.5 miles west of Langford, on land owned by Nathaniel Richmond just north of main east and west road, 225 feet north of house of Charles Cook, 10 feet northeast of old well. Station mark: A stone post 48 by 6 by 6 inches, set 44 inches in ground, having in center of top of post a copper bolt stamped "U. S. G. S. 458 N. Y."	42 35 16.2	78 52 37.2
Four corners at schoolhouse	42 35 14.3	78 52 18.5
Langford, four corners	42 35 14.2	78 50 31.7
New Oregon, four corners	42 35 17.8	78 47 31.3

HERKIMER AND LEWIS COUNTIES.

McKEEVER QUADRANGLE.

The following geographic positions were determined from primary traverse by Mr. E. L. McNair, topographer, in 1904: The line starts at Bald Mountain triangulation station, follows trails to Fulton Chain station, New York Central Railroad; thence westward via roads and trails along northern border of quadrangle to Brantingham. It also follows the New York Central Railroad from Fulton Chain to White Lake station. A loop was run via trails from McKeever east, south, and west to White Lake station and continued to Boonville triangulation station. A line was also run along highways from McKeever to Port Leyden. Positions are given on the United States standard datum.

Geographic positions along trails from Bald Mountain triangulation station to Brantingham.

Station.	Latitude.	Longitude.
Bald Mountain triangulation station; a bare rocky summit on the northern shore of Third Lake of the Fulton Chain. Station mark: A copper bolt cemented in solid rock stamped "U. S. G. S. N. Y. 481"	° ′ ″ 43 44 19.3	° ′ ″ 74 54 47.1
Forks of road and trail to Bald Mountain from Bald Mountain House	43 44 20.9	74 54 04.2

Geographic position along trails from Bald Mountain triangulation station, etc.—Cont'd.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Old Forge, center of iron bridge across river at fish hatchery	43 42 45.8	74 58 12.8
Fulton Chain railroad station, 22 feet east of center of main track, 10 feet north of hotel porch, in bowlder, bronze tablet stamped "Elev. 1712 feet"	43 41 57.1	75 00 19.9
Tate road crossing, 750 feet north of milepost 59 (line leaves railroad and follows Tate road to Blackfoot Pond)	43 42 55.2	75 00 06.5
Dead tree, 25 feet west of road, cloth penalty notice marked with red ink "Sta. 92"	43 43 03.3	75 00 44.2
Beech tree (dead), cloth penalty notice marked with red pencil "Sta. 103"	43 43 26.1	75 01 14.0
Wakely's first lumber camp, 75 feet from, on dead maple tree west side of road, cloth penalty notice marked with red pencil "Sta. 115+470′"	43 43 54.4	75 01 05.6
Spruce tree (dead) on west side of road, cloth penalty notice marked with red pencil "124+377′"	43 44 27.8	75 01 07.5
Blackfoot Pond, 200 feet northwest of outlet, at Wakely's camp, on live birch tree beside trail, cloth penalty notice marked "136"	43 44 33.4	75 01 42.2
Spruce tree beside trail, cloth penalty notice marked "153+10′"	43 44 37.0	75 02 10.9
East Pond, south side of, on spruce tree beside trail, cloth penalty notice marked "Sta. 166"	43 44 19.7	75 02 55.7
Beech tree beside trail, cloth penalty notice marked "Sta. 184"	43 44 15.5	75 03 51.7
Birch tree beside trail, cloth penalty notice marked in red "199+65′"	43 44 11.6	75 04 34.1
Beech tree beside trail, cloth penalty notice marked in red "213+40′"	43 44 05.9	75 05 19.3
Birch tree, cloth penalty notice	43 43 47.3	75 05 57.4
Otter Lake House, 135 feet from, and between house and barn, in face of large bowlder, bronze tablet stamped "Prim. Trav. Sta. No. 234"	43 43 49.3	75 06 45.4
Herkimer-Lewis county line, iron milepost marked "No. 18; 7.40 miles," 700 feet northeast of dam at outlet of Otter Lake, 15 feet northwest of road	43 43 19.9	75 07 25.7
Maple tree, cloth penalty notice	43 43 11.4	75 08 18.0
Small birch tree on north side of road, cloth penalty notice marked "Sta. 288"	43 43 11.0	75 09 07.8
Maple tree beside road	43 43 31.4	75 09 55.6
Hubbard's place on Otter Creek, 30 feet south of porch	43 43 35.4	75 10 32.3
Beech tree 15 feet south of road, 100 feet west of plank bridge over low place, cloth penalty notice marked in red "344+40′"	43 43 01.8	75 11 54.4
Small bridge, cloth penalty notice marked "Sta. 1234+90′"	43 42 55.1	75 14 43.6
Patridgeville (abandoned), old sawmill dam, on bridge	43 43 07.3	75 15 27.9
Brantingham post-office, 1.7 miles northeast of, on road up Otter Creek, in large rock outcrop, on northwest side of road and 15 feet higher than road, bronze triangulation tablet stamped "Prim. Trav. Sta. No. 1215"	43 42 31.7	75 16 14.3

Geographic positions along the New York Central Railroad between Fulton Chain and White Lake.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Milepost H 57	43 41 15.2	75 00 56.7
Milepost H 56	43 40 43.3	75 01 52.4
Milepost H 55	43 40 13.2	75 02 49.4
Milepost H 54	43 39 46.4	75 03 48.8
Minnehaha flag station	43 39 43.0	75 04 06.0
Milepost H 53	43 39 19.1	75 04 41.0
Milepost H 52	43 38 32.4	75 04 15.0
Milepost H 51	43 37 51.2	75 04 56.2
Milepost H 50	43 37 08.9	75 05 03.4
McKeever station, 550 feet south of, in solid ledge in cut, copper bolt stamped "U. S. G. S." "elev. 1544 ft. R."	43 36 38.1	75 05 57.2
Milepost H 47	43 35 06.0	75 07 05.2
Milepost H 46	43 34 19.1	75 07 32.8
Milepost H 45	43 33 31.0	75 07 59.3
Milepost H 44	43 32 42.1	75 08 22.2
Milepost H 43	43 31 49.9	75 08 23.1

Geographic positions along trails and roads from McKeever east, south, and west to Boonville.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Beech tree on north side of road, cloth penalty notice marked "Sta. 433+90′"	43 36 33.3	75 05 03.5
Large birch tree, cloth penalty notice marked "Sta. 453+227′"	43 36 41.8	75 03 59.2
Beech tree, cloth penalty notice marked "Sta. 472"	43 36 46.9	75 02 55.2
Beech tree, cloth penalty notice marked "Sta. 492+15′"	43 37 01.8	75 02 02.3
Large birch tree, cloth penalty notice marked "Sta. 507"	43 36 33.9	75 01 30.2
Woodhull Lake Landing, 0.25 mile from, forks of road	43 36 12.3	75 01 21.3
Large birch tree, cloth penalty notice marked "Sta. 528"	43 35 44.1	75 01 18.0
Curriers Camp, on birch tree, cloth penalty notice marked "Sta. 547+123"	43 35 20.3	75 01 25.1
T. B. M. painted elev. in red "U. S. G. S. B. M. 1958 ft."	43 35 00.4	75 01 28.6
Beech tree, 40 feet north of road, cloth penalty notice marked "Sta. 568+10"	43 34 57.0	75 01 48.4
T. B. M. elev. painted in red "G. S. 1897 ft."	43 34 51.4	75 02 22.2
Maple tree, signboard, "Woodhull 4 mi. White Lake Corner 7 mi."	43 34 23.1	75 02 55.7
Large rock on south side of road, elev. marked in red paint "G. S. 1690 ft."	43 33 59.4	75 03 25.2
Rock in middle of road, elev. marked in red paint "G. S. 1624 ft."	43 34 01.2	75 03 35.1

Geographic positions along trails and roads from McKeever east, etc.—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Gull Lake, near road to, on plank of bridge, cloth penalty notice marked "Sta. 656+167"	43 33 32.7	75 04 26.9
Rock south side of road, elev. painted in red "G. S. 1671 ft."	43 32 50.2	75 05 34.2
Herkimer-Oneida county line, stone monument marked "H↕O" on top, "1888" on side	43 32 27.7	75 06 07.6
White Lake station, New York Central Railroad, road crossing, 400 feet south of	43 31 19.9	75 08 23.6
White Lake station, in bowlder 81 feet west of railroad and 10 feet north of road, copper bolt stamped "elev. U. S. G. S. R. 1421 B. M."	43 31 19.8	75 08 24.7
White Lake Corners, post-office, four corners	43 31 14.7	75 09 17.4
Second-class road northwest, at spruce tree on north side of road	43 31 09.0	75 10 28.0
Forks of road, 25 feet west of telephone pole	43 30 56.0	75 12 24.0
Cummings Creek, 25 feet east of channel, 10 feet north of bridge, in solid ledge of rock, bronze triangulation tablet stamped "Prim. Trav. Sta. No. 811"	43 30 23.2	75 13 19.5
Road north	43 30 00.8	75 14 56.2
Road north	43 29 44.7	75 16 24.6
Hawkinsville, four corners	43 29 36.6	75 16 38.6
Forks of road, three corners 40 feet west of wild cherry tree.	43 28 58.8	75 17 57.7

Geographic positions along highways, Port Leyden, via Moose River, to McKeever.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Lyonsdale, school district No. 2, in road opposite schoolhouse	43 34 16.1	75 15 15.8
Porters Corners, 500 feet west of forks of road, 75 feet north of road; in large bowlder in pasture, bronze tablet stamped "Prim. Trav. Sta. 983"	43 34 19.0	75 14 11.0
Earl's (George W.) residence, in road opposite front gate.	43 35 11.3	75 13 11.3
Telephone pole on north side of road marked with red "Sta. 1005+35"	43 35 47.6	75 11 51.0
Scharbonneau (William) residence, in road opposite front gate	43 36 07.0	75 11 14.9
Maple tree opposite unoccupied house on south side of road, cloth penalty notice, fence marked "Sta. 1033"	43 36 27.1	75 10 14.6
Moose River House, on telephone pole at corner of yard, cloth penalty notice	43 36 25.8	75 09 31.8
Telephone pole, cloth penalty notice marked "Sta. 1052+195"	43 35 59.8	75 09 15.8
Beech tree on north side of road, cloth penalty notice marked "Sta. 1079"	43 36 18.2	75 08 05.0
Forest Home Hotel, in center of road opposite east end of.	43 36 36.4	75 06 37.4
Herkimer, Lewis, and Oneida counties, corner of, 2,000 feet north of Forest Home Hotel, a drill hole in small bowlder marked "$\frac{L}{O}$/H"	43 36 54.7	75 06 37.8

LEWIS COUNTY.

PORT LEYDEN QUADRANGLE.

The following geographic positions were determined by Mr. E. L. McNair, topographer, in 1904. The line starts at Boonville flagstaff, previously located by triangulation, follows highways westward, and is tied to forks of road at Highmarket post-office, located by primary traverse in 1902. Another line leaves the first line at a point 3½ miles west of Port Leyden, passes through that place, and is connected with Schwartz triangulation station; thence continues north to Brantingham and west to a position located by primary traverse in school district No. 21, Martinsburg Township.

Geographic positions along highways between Boonville and Highmarket.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Boonville, flagstaff in public park	43 28 47.61	75 19 23.79
Boonville, northeast corner of Post and West streets	43 29 11.0	75 20 12.1
Forks of road, 50 feet south of iron signboard, "Constableville 5 mi., Talcottville 1½ miles"	43 30 47.6	75 21 41.3
Road west, signboard, "Constableville 6 miles, W. Leyden 6 miles"	43 31 44.7	75 22 52.2
Road northeast, Port Leyden 3½ miles	43 32 50.6	75 24 09.4
Sugar River, south end of iron bridge over	43 33 25.0	75 24 33.5
Constableville, four corners at Catholic church	43 33 59.3	75 25 42.5
S. T. Parkhurst residence, forks of road 400 feet east of	43 33 54.2	75 26 56.6
Old sawmill near cheese factory, creek crossing	43 34 12.1	75 27 44.7
Highmarket, forks of road in front of post-office	43 35 06.5	75 31 08.1
Highmarket, 900 feet south of post-office, in solid ledge, B. M. tablet	43 34 57.8	75 31 07.5

Geographic positions along highways from a point 2 miles southwest of Port Leyden east and north, via Schwartz triangulation station, to Brantingham, thence west to Martinsburg.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Port Leyden, 2 miles southwest of four corners	43 33 48.7	75 22 29.4
Port Leyden, street crossing New York Central Railway	43 34 57.2	75 20 48.6
Port Leyden, Hotel Brunswick, front face in brickwork, bronze bench-mark tablet stamped "Elevation 897 ft. Albany, 1900" (898.400)	43 34 57.7	75 20 47.7
Port Leyden, 2 miles east of, forks of road	43 34 47.0	75 18 40.8
Five corners	43 34 24.6	75 16 56.0
Villiers, T corners, 875 feet east of Bethel Baptist Church	43 36 00.8	75 16 44.0
Fowlerville, south end of span bridge across Moose River	43 37 24.4	75 16 27.0
Lyonsdale, school district No. 7, four corners at school-house	43 38 10.9	75 18 14.2

Geographic positions along highways, etc.—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T corners at road east, cloth penalty notice on fence post marked "sta. 1165"	43 39 29.0	75 16 21.0
Four corners	43 39 27.4	75 16 52.5
Four corners	43 39 24.1	75 17 53.2
Schwartz triangulation station, in Greig Township, 0.5 mile east of Schwartz schoolhouse. Station mark: A granite post set in ground; in center of top of post is cemented a copper bolt	43 39 09.63	75 19 28.37
Fish Creek, bridge over	43 39 56.2	75 17 34.3
Forks of road at schoolhouse	43 40 58.8	75 17 40.9
Brantingham post-office, four corners	43 41 19.6	75 17 33.7
Greig post-office, three corners 0.5 mile north of	43 41 14.6	75 21 21.6
Forks of road	43 42 05.3	75 22 03.9
Forks of road (northeasterly to Chases Lake)	43 42 32.2	75 23 30.5
Glenfield, in face of foundation of New York Central Railway station, bronze tablet	43 42 37.8	75 24 09.4
Glendale, crossing of Whetstone Creek	43 42 59.0	75 25 00.2
Goodrich's, four corners	43 43 22.0	75 26 08.2
Martinsburg, four corners at schoolhouse district No. 1	43 42 51.3	75 27 48.7
Wakefield, four corners	43 43 17.9	75 28 45.9
Martinsburg, road west at schoolhouse	43 42 32.8	75 29 35.3
Martinsburg, school district No. 21, in large bowlder in field 244 feet from corner of schoolhouse, mag. bearing S. 6° 30′ E., bronze triangulation tablet stamped "Prim. Trav. Sta. 1342"	43 42 31.0	75 29 34.6

NORTH CAROLINA AND SOUTH CAROLINA.

PRIMARY TRAVERSE.

CABARRUS, GASTON, IREDELL, LINCOLN, MECKLENBURG, AND ROWAN COUNTIES, N. C.; YORK COUNTY, S. C.

CHARLOTTE 30-MINUTE QUADRANGLE.

The following geographic positions were determined from primary traverse in 1904, by Mr. C. B. Kendall, field assistant. The line starts from the cupola of Simonton College at Statesville, N. C., a Coast and Geodetic Survey triangulation station, and follows the Charlotte Branch of the Southern Railway to Davidson; thence west along public highways along north border of Charlotte quadrangle to Triangle post-office, thence south along public highways to Fort Mill, S. C. From Fort Mill the line follows public highways east to Monroe, N. C.; thence north along public highways to Salisbury; thence along the Asheville Branch of the Southern Railway northwest to Barber Junction; thence north along trail to Young triangulation station, United States Coast and Geodetic Survey.

A line was also run, beginning at Davidson and following public highways, east along north boundary of quadrangle to Rimer.

Positions are given on United States standard datum.

Geographic positions along highways between Davidson and Triangle.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Davidson station, 50 feet south of; street crossing, center of track at	35 30 01.9	80 50 58.7
Davidson, 1.25 miles west of; bridge over stream, center of.	35 29 31.1	80 52 09.9
Davidson, 1.75 miles west of; Knox's gin, forks at, 15 feet northwest to oak tree, 25 feet east to oak tree	35 28 52.4	80 53 12.7
T road to south (second class), 15 feet south to mail box.	35 29 12.3	80 54 14.9
Catawba Ferry, 0.9 mile east of; forks, road south down east bank of river, 200 feet northwest to small dwelling.	35 29 13.8	80 55 52.6
Catawba or Sherrells Ferry, east bank at landing	35 29 20.2	80 56 48.7
Battles Ford, 0.5 mile west of; four corners, 75 feet northwest to corner of old store, 45 feet southwest to corner of old store	35 29 51.4	80 58 05.6
Unity Presbyterian Church, forks of road just north of, 25 feet east to stump, 20 feet southeast to end of old log	35 29 05.4	80 59 04.4
Triangle at northeast corner of post-office, store of Robert Nixon, iron post stamped "PRIM. TRAV. STA. No. 199"	35 28 34.8	80 59 49.4

Geographic positions along highways between Triangle, N. C., and Fort Mill, S. C.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Triangle, 1.5 miles south of; four corners, 60 feet west to large oak, 70 feet south to telegraph pole	35 27 24.1	80 59 31.8
Hagar post-office (discontinued), T road to east, 5 feet southeast to cedar post	35 26 34.9	80 59 24.7
Store, 500 feet south of; T road to northwest, 30 feet north to mail box, 35 feet south to telephone pole	35 26 21.7	81 00 02.8
Hills Chapel, 350 feet south of, forks of second-class road to east, 45 feet north to telephone pole, 50 feet south to tombstone	35 25 28.0	81 00 37.7
Lowesville, four corners at, 60 feet southwest to corner front-yard fence, 40 feet southeast to corner of store porch	35 25 00.7	81 00 39.5
Lucia post-office, at southwest corner of post-office, store of A. U. Straup, iron post stamped "Prim. Trav. Sta. No. 242"	35 23 07.3	81 00 37.1
Lucia, 1 mile south of; at top of hill, forks of road, 20 feet west to telephone pole	35 22 25.2	81 00 08.1
Abernathy's store, on "Open View Farm," 150 feet south of; forks of road to east, 35 feet south to telephone pole.	35 21 20.9	80 59 35.2
Store, 750 feet southeast of; four corners, 20 feet southwest to telephone pole, 45 feet east to large pine	35 19 57.8	80 59 51.0
Green schoolhouse, forks of road; 40 feet southeast to telephone pole, 70 feet south to small oak	35 18 52.8	81 00 48.2

Geographic positions along highways between Triangle, N. C., and Fort Mill, S. C.—Cont'd.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Mount Holly, Main street crossing of Seaboard Air Line Railway, center of track	35 17 51.5	81 00 58.3
Mount Holly, at south edge of, four corners, public crossroads, 45 feet north to fence corner, 25 feet east to telephone pole	35 17 16.6	81 01 11.6
Mount Holly, 1.75 miles south of; second-class crossroads, 30 feet south to telephone pole	35 16 30.5	81 01 49.7
St. Marys College, 0.25 mile north of; at end of macadam road, public crossroads, 20 feet southeast to sign tree "Tuckasege Ferry, 1 mile, Charlotte, 11.5 miles," 35 feet north to telephone pole	35 15 57.4	81 02 22.7
Belmont station, 75 feet east of; street crossing of Southern Railway, center of main track	35 14 32.1	81 02 16.9
Belmont station, 200 feet north of; on sidewalk opposite southwest corner of store of L. P. Stowe, iron post stamped "Prim. Trav. Sta. No. 338 (A)"	35 14 32.8	81 02 18.0
Belmont, 1 mile east of; road crossing, center of track	35 14 13.1	81 01 20.2
Catawba River, Southern Railway bridge over, center of stream	35 14 07.9	81 00 38.7
Catawba River, 0.75 mile east of; road crossing, south rail	35 13 57.3	80 59 42.5
Paw Creek, 0.5 mile east of; public road crossing, south rail	35 13 46.8	80 58 27.9
Southern Railway, 0.75 mile south of; four corners, 30 feet southeast to signpost "Charlotte 7.25 miles, Ft. Mill 17.25 miles," 40 feet west to oak tree	35 13 24.7	80 57 44.5
Dixie post-office, 230 feet south of; junction with macadamized road, 40 feet west to oak tree, 115 feet southwest to signpost "Ft. Mill 16 miles"	35 12 11.7	80 57 42.9
Steel Creek Church, 600 feet south of; forks of road; 10 feet southeast to post	35 10 55.1	80 57 23.2
Shopton post-office, 400 feet south of; forks of road south and southeast, 10 feet south to small bridge, 50 feet west to oak tree	35 10 08.1	80 57 49.7
Shopton, 1 mile south of; forks of road north and northwest	35 09 21.0	80 58 08.6
Shopton, 2.4 miles south of; T road east at small whitewashed house, 45 feet east to corner of house	35 08 14.0	80 58 40.4
Kendricks crossroads, 2 miles north of; at dwelling on top of small hill, forks second-class road to east, 40 feet west to chimney, 55 feet east to locust tree	35 07 45.6	80 58 52.6
Kendricks crossroads, 1 mile east of Romesburg; 50 feet east of front door of store of J. R. Baine; in southwest corner of intersection of roads, iron post stamped "Prim. Trav. Sta. No. 417"	35 06 06.5	80 59 24.4
Kendricks crossroads, 0.75 mile south of; at cotton gin, second-class crossroads, 45 feet southeast to corner of gin, 45 feet southwest to corner of garden	35 05 32.6	80 59 32.9
North Carolina-South Carolina State line, center of road at	35 04 29.0	80 59 21.3

Geographic positions along highways between Triangle, N. C., and Fort Mill, S. C.—Cont'd.

Station.	Latitude.	Longitude.
SOUTH CAROLINA—YORK COUNTY.		
North Carolina-South Carolina State line, 1 mile south of, three corners public road to Pineville, 40 feet northeast to oak tree, 35 feet west to back-yard gate	° ′ ″ 35 03 41.5	° ′ ″ 80 59 29.7
Forks, road leading west to Charlotte Electric Power Co.'s dam, 30 feet southwest to persimmon tree, 35 feet northwest to elm	35 02 46.1	80 59 20.7
Charlotte Electric Power Co.'s line of wires, center of road under	35 02 07.6	80 58 29.7
Fort Mill, 2 miles north of; at brick store, T road, 25 feet to north end of store, 40 feet to south end of store	35 01 45.5	80 57 59.0
Fort Mill, in south wall at southwest corner of Fort Mill Bank building, at junction of Main and Confederate streets, aluminum tablet stamped "Prim. Trav. Sta. No. 468"	35 00 27.5	80 56 39.8

Geographic positions along highways between Fort Mill, S. C., and Monroe, N. C.

Station.	Latitude.	Longitude.
Fort Mill, 1 mile southeast of; forks of road, center of triangle at; 45 feet southwest to telephone pole	° ′ ″ 35 00 08.5	° ′ ″ 80 55 45.4
Fort Mill, 1.75 miles southeast of; forks of road east and northeast	35 00 31.6	80 54 54.6
Sugar Creek, bridge over center of creek	35 00 22.4	80 54 08.8
Sugar Creek, 0.8 mile east of; three corners, east up north and south road at, 40 feet west to rock	35 00 20.2	80 53 18.1
Pleasant Valley, 0.75 mile north of, T road 75 feet north to telephone pole, 75 feet west to telegraph pole	35 00 05.8	80 51 22.7
Pleasant Valley, at northeast corner of front yard to residence of J. W. Davidson, iron post stamped "Prim. Trav. Sta. No. 523"	34 59 36.6	80 51 07.8
Sixmile Creek, 250 feet east of bridge over, four corners, 40 feet southeast to blazed elm tree	34 59 28.0	80 50 39.8
North Carolina-South Carolina State line, center of road at	34 59 39.0	80 50 02.4
NORTH CAROLINA.		
Poortith post-office, 200 feet southeast of; road forks south and east, 35 feet south to oak tree, 50 feet west to corner of shop	34 59 29.9	80 48 54.3
Marvin Church, 500 feet east of; at top of hill, second-class roads, 25 feet south to oak tree, 40 feet northeast to cedar tree	34 59 29.1	80 48 04.8
Marvin Church 1.6 miles east of; four corners, Charlotte and Camden road (telephone line), 30 feet northeast to pine tree, 40 feet southeast to telephone pole	34 59 18.9	80 46 31.8
Wolfsville post-office, 1.2 miles west of; four corners, 40 feet south to pine tree	34 59 26.3	80 45 23.8

Geographic positions along highways between Fort Mill, S. C., and Monroe, N. C.—Cont'd.

Station.	Latitude.	Longitude.
NORTH CAROLINA—continued.		
Wolfsville post-office, at southwest corner of post-office and store of R. D. Redwine, 500 feet east of road forks, iron post stamped "Prim. Trav. Sta. No. 598."	° ′ ″ 34 59 09.5	° ′ ″ 80 44 14.0
Union Church, 500 feet west of; forks of road to south (telephone line), 40 feet south to telephone pole	34 58 54.2	80 43 24.5
Union Church, 1 mile east of; four corners, 15 feet southeast to oak tree, 40 feet west to telephone pole	34 59 02.7	80 42 19.1
Vance post-office, 200 feet east of; forks of road to north, 40 feet west to telephone pole	34 59 02.1	80 41 21.8
Oak Grove Church, 300 feet west of; four corners, 35 feet southeast to telephone pole, 80 feet west to oak tree	34 58 31.5	80 39 38.3
Oak Grove Church, 2.1 miles southeast of; four corners	34 57 55.1	80 37 19.1
Monroe, 2 miles west of; Seaboard Air Line Railway crossing, center of track at	34 58 43.1	80 35 03.9
Monroe, 1 mile west of; forks of road south and west of; 25 feet northeast to telephone pole, 35 feet south to hedge fence	34 58 56.9	80 34 20.2
Monroe, at Union County court-house, in southeast corner of square, south meridian stone United States Coast and Geodetic Survey	34 58 57.8	80 32 59.3
Monroe, Union County court-house, set in south wall at southeast corner of; aluminum tablet stamped "Prim. Trav. Sta. No. 659 (A)"	34 58 58.2	80 32 59.8

Geographic positions along highways between Monroe and Rimer.

Station.	Latitude.	Longitude.
Monroe, 0.75 mile north of; forks of Concord and Charlotte roads, 30 feet east to telephone pole, 45 feet southwest to telephone pole	° ′ ″ 34 59 23.5	° ′ ″ 80 33 16.2
Monroe, 2.2 miles north of; public crossroads, 20 feet east to telephone pole	35 00 40.6	80 32 46.5
Monroe, 3.3 miles north of; public crossroads, 30 feet southeast to telephone pole, 40 feet west to pine tree	35 01 36.8	80 32 24.1
Monroe, 5 miles north of; second class east and west crossroads	35 03 07.1	80 31 50.1
Monroe, 6.2 miles north of; forks of road leading northeast to Unionville, 60 feet east to telephone pole, 50 feet north to road to west	35 04 29.3	80 31 50.9
Crooked Creek, Scotts bridge, 2.7 miles south of; forks second-class road to west	35 05 27.4	80 31 58.6
Crooked Creek, Scotts bridge, 2.1 miles south of; four corners at church, 40 feet northwest to oak tree, 50 feet east to oak tree	35 06 14.3	80 32 12.4
Crooked Creek, Scotts bridge, 0.5 mile south of; second class T road to east, 35 feet northeast to pine tree at gate, 30 feet southeast to holly bush	35 07 23.8	80 32 11.2

Geographic positions along highways between Monroe and Rimer—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Loveslevel, 0.75 mile west of; in southeast corner of intersection of Monroe-Concord and Charlotte-Wadesboro road, iron post stamped "Prim. Trav. Sta. No. 733"	35 08 17.2	80 32 16.0
Longs Mill, T road to east at; 25 feet north to bridge over mill road, 40 feet west to corner of mill	35 09 11.2	80 32 08.3
Longs Mill, 1 mile north of; four corners, 60 feet southwest to blacksmith shop, 30 feet east to oak tree	35 09 55.2	80 32 28.6
Schoolhouse, four corners at; 25 feet northeast to telephone pole, 35 feet west to oak tree	35 11 01.7	80 32 17.8
Brief post-office, 0.6 mile north of; Cabarrus-Union county line stone, 185 feet north of; T road to west; 40 feet southwest to telephone pole, 35 feet northwest to signpost, Mount Pleasant 17 miles, Concord 17 miles	35 11 49.8	80 31 39.0
Cabarrus-Union county line, 1 mile north of; T road to east	35 12 33.5	80 31 17.5
Mill Hill Camp ground, forks of road; road to east; 25 feet south to oak tree	35 13 44.0	80 30 31.9
Mill Hill Camp ground, 1.1 miles north of; four corners, second-class crossroads, 35 feet southwest to oak tree, 40 feet east to persimmon tree	35 14 38.9	80 30 12.8
Furrs post-office, 1.9 miles south of; Charlotte-Albermarle, Concord-Monroe roads, intersection of; in northeast corner of, iron post stamped "Prim. Trav. Sta. No. 798"	35 14 58.7	80 30 06.9
Anderson Creek, ford of, center of road at	35 15 53.6	80 29 55.6
Furrs post-office, forks at; road to northwest, 35 feet southeast to fence corner, 90 feet west to front door of store (post-office)	35 16 31.3	80 29 50.2
Furrs post-office, 1 mile north of; road forks, second-class road to east	35 17 18.9	80 29 19.9
Furrs, 1.8 miles north of; T road to northwest at small dwelling, 40 feet east to apple tree	35 17 56.0	80 29 20.2
Rocky River, center of Huyler's bridge over	35 18 49.8	80 28 44.1
Rocky River, 1.6 miles north of; T road to west; 35 feet east to pine tree, 25 feet north to double oak	35 19 56.8	80 27 47.8
Rocky River, 2.5 miles north of; four corners; 30 feet northwest to oak tree, 30 feet southwest to mail box	35 20 37.0	80 27 17.6
Forks of roads to west, 10 feet southwest to mail box	35 21 26.1	80 27 00.1
Mount Pleasant, 2.1 miles south of; forks of roads north to Mount Pleasant and west to Concord; 20 feet east to large oak tree	35 22 34.2	80 26 51.8
Success, 3.5 miles southeast of; forks of road to north; 15 feet north to mail box	35 22 46.9	80 28 31.6
Success, 1.8 miles southeast of; T road to southwest; 50 feet south to mail box, 10 feet east to large oak stump	35 23 37.5	80 29 46.3
Success, 1 mile southeast of; forks of road; 40 feet north to hickory tree, 30 feet northwest to hickory tree	35 24 02.9	80 30 11.9
Concord, 4 miles east of; formerly Success post-office, at northwest corner of vacant store in southeast corner of intersection of Concord-Mount Pleasant road with north and south road; iron post stamped "Prim. Trav. Sta. No. 954"	35 24 52.6	80 30 48.1

Geographic positions along highways between Monroe and Rimer—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Success, 1.3 miles north of; forks of road to northwest; 25 feet west to large hickory, 40 feet north to pine tree.	35 25 55.2	80 30 36.4
Rimer, 3 miles south of; 300 feet south of cotton gin, forks of road; 35 feet northwest to post, 35 feet northeast to pine root	35 26 53.7	80 30 35.1
Buffalo Creek, center of bridge over	35 27 13.7	80 29 46.1
Rimer, 1 mile south of; at blacksmith shop, T road north, 50 feet north to corner of shop	35 27 24.6	80 28 53.6
Rimer, set opposite T road east, at west line of front yard fence to residence of W. D. Barrier, iron post stamped "Prim. Trav. Sta. No. 1016"	35 28 36.0	80 28 52.0
Rimer, 1.2 miles north of; T road west, center of north and south road	35 29 38.2	80 28 47.4

Geographic positions along highways between Davidson and Rimer.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Davidson, Davidson Presbyterian Church, set in south wall at southeast corner of; aluminum tablet stamped "Prim. Trav. Sta. No. 2 (A)"	35 29 57.3	80 50 53.2
Davidson, 2 miles east of; forks of road to south (second class)	35 29 02.5	80 49 11.8
Davidson, 4.5 miles east of; T road to south, 30 feet north to pine tree, 35 feet east to clump of small locust trees	35 28 27.5	80 47 54.1
Rocky River, 0.3 mile west of; near top of hill, second-class road, 20 feet south to small elm, 30 feet north to small elm	35 28 23.8	80 47 06.9
Rocky River, Mecklenburg-Cabarrus county line, center of bridge over	35 28 29.7	80 46 46.3
Coddle post-office, 1 mile south of; three corners	35 28 57.6	80 45 58.4
Coddle post-office, 1 mile south of; 150 feet southwest of three corners, 200 feet west of northwest corner of residence of G. H. Hamilton, in top of large granite bowlder, aluminum tablet stamped "Prim. Trav. No. 50 (A)"	35 28 57.4	80 46 00.2
Erskine post-office, 0.75 mile west of; forks of road to northwest, 40 feet northwest to dead tree stump, 15 feet southwest to small stump	35 29 10.6	80 44 15.6
Coddle Creek, 0.25 mile east of; forks of road 30 feet west to oak stump	35 29 00.3	80 42 40.6
Mill Hill post-office, three corners at, second-class road to south, 30 feet north to elm	35 29 11.7	80 41 33.9
Mill Hill, 0.5 mile east of; four corners, 60 feet west to oak tree, 10 feet south to large store	35 29 10.9	80 41 07.9
Mill Hill, 1.8 miles east of; forks of road southeast and northeast, 30 feet north to hickory tree	35 29 07.6	80 39 59.3
Schoolhouse, four corners at, 65 feet south to pine tree	35 29 13.6	80 38 11.5
Glass post-office, at southeast corner of; iron post stamped "Prim. Trav. Sta. No. 150"	35 28 29.3	80 37 27.3

Geographic positions along highways between Davidson and Rimer—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Glass post-office, 1 mile north of; forks of road; 10 feet southwest to mail box	35 29 23.8	80 37 19.8
Church, 400 feet south of; forks of road; 20 feet east to oak in triangle	35 28 50.2	80 36 50.3
Dog Trot, church at forks of road; front door of	35 28 23.8	80 36 24.6
Helemons Mill, forks of road; 25 feet north to front door of store, 35 feet south to mill door	35 28 49.2	80 34 48.5
Helemons Mill, 0.75 mile east of; three corners, 10 feet northwest to mail-box post	35 28 40.6	80 34 11.9
Helemons Mill, 1.4 miles east of; four corners; 10 feet west to pine tree	35 29 05.3	80 33 34.5
Helemons Mill, 3.5 miles east of; four corners, north and south and east and west roads, 10 feet northwest to telephone pole, 35 feet south to oak tree	35 30 28.7	80 32 11.4
Yost post-office, 1.5 miles west of; four corners, Irish Potato road, 15 feet southeast to elm, 45 feet north to corner of fence	35 30 13.6	80 31 14.2
Yost, 0.5 mile northwest of; forks of road; 10 feet south to oak tree	35 30 25.6	80 30 11.1
Yost, 0.75 mile east of; forks of road; 25 feet northwest to oak tree, 30 feet southeast to pine tree	35 29 59.4	80 29 31.7
Rimer, 1.2 miles north of; T road west; center of north and south road	35 29 38.2	80 28 47.4

IREDELL AND ROWAN COUNTIES.

STATESVILLE QUADRANGLE.

Geographic positions along Southern Railway from Statesville to Davidson.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Statesville, Simonton College cupola, United States Coast and Geodetic Survey station (Geodetic value)	35 46 57.8	80 53 39.0
Statesville, Southern Railway passenger station, 80 feet west of, center of main track	35 46 34.2	80 53 03.6
Statesville, 1.8 miles south of; road crossing, center of track	35 45 44.6	80 53 04.5
Third Creek, 0.75 mile south of; road crossing, center of track	35 44 23.7	80 53 24.0
Barium station, 600 feet north of; road crossing, center of track	35 43 17.8	80 53 46.5
Barium station, 1 mile south of; road crossing, center of track	35 42 30.0	80 53 37.7
Ostwalt station, 1.3 miles north of; road crossing, center of track	35 41 39.4	80 52 26.2
Ostwalt station, 300 feet south of; road crossing, center of track	35 40 46.6	80 51 33.0
Ostwalt station, in brick foundation under bay window at south corner of dwelling of F. K. Ostwalt, aluminum tablet *stamped "Prim. Trav. Sta. No. 41 (A)"*	35 40 51.2	80 51 34.4

Geographic positions along Southern Railway from Statesville to Davidson—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Ostwalt station, 0.75 mile south of; road crossing, center of track	35 40 15.0	80 51 12.4
Shepherd station, 1,000 feet north of; road crossing, center of track	35 38 07.7	80 49 41.1
Shepherd station, 0.2 mile south of; road crossing, center of track	35 36 26.3	80 48 56.8
Mooresville Junction, switch point of junction of Caroline, Midland and Statesville branch of Southern Railway, center of track	35 35 36.4	80 48 27.1
Moores station, 100 feet west of; at northwest corner of Broad and First North streets, in east wall at southeast corner of Templeton Williams & Co.'s brick store, aluminum tablet stamped "Prim. Trav. Sta. No. 81 (A)".	35 34 58.5	80 48 48.0
Mooresville, 1 mile south of; road crossing, center of track.	35 34 20.6	80 49 31.3
Milepost 26, 260 feet south of; road crossing, center of track	35 33 27.4	80 50 20.2
Mount Mourn station, at south end of; road crossing, center of track	35 32 28.7	80 50 53.6
Mount Mourn station, 1.4 miles south of; road crossing at forks of road, center of track	35 31 16.7	80 50 31.1
Davidson station, 50 feet south of; street crossing, center of track	35 30 01.9	80 50 58.7

Geographic positions along highways from Rimer to Salisbury.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Rimer, 1.2 miles north of; T road west, center of north and south road at	35 29 38.2	80 28 47.4
Rimer, 2.2 miles north of; forks of road to southeast, 25 feet northeast to oak tree, 30 feet west to oak tree	35 30 02.9	80 28 03.9
Organ Church post-office, 0.75 mile north of; T road south, 30 feet southeast to fence post, 20 feet northeast to persimmon tree	35 31 29.6	80 27 32.6
Organ Church, just east of; four corners, intersection Gold Hill-China Grove and Mount Pleasant-Salisbury roads, 35 feet northwest to oak tree, 30 feet southwest to post	35 31 42.0	80 26 52.9
Organ Church, 1.25 miles north of; T road to south, double oak at north edge of road	35 32 50.4	80 27 05.2
Faith, 1 mile south of; forks of road to southwest, 30 feet south to oak tree	35 34 10.9	80 27 33.9
Faith, in northeast corner of yard to Faith Lutheran Church, in side of large granite bowlder, aluminum tablet stamped "Prim. Trav. Sta. No. 1116"	35 35 00.4	80 27 41.6
Faith, 1 mile north of; four corners, 20 feet west to gum tree, 25 feet southeast to corner of garden	35 36 02.5	80 27 51.7
Cane Creek, center of bridge over	35 26 44.4	80 27 55.1
Salisbury, 3 miles south of; forks of road to southeast, 90 feet southeast to persimmon tree, 40 feet southwest to fence corner	35 37 36.9	80 27 27.1

Geographic positions along highways from Rimer to Salisbury—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Salisbury, 2.6 miles south of; Southern Railway crossing, 4 feet north of north rail	35 37 55.0	80 27 21.8
Salisbury, 1 mile south of; forks of road, 140 feet southeast to milestone No. 1, 40 feet south to telephone pole.	35 39 21.3	80 27 30.6
Salisbury, Rowan County court-house, in south wall at southeast corner, bronze tablet stamped "Prim. Trav. Sta. No. 1159—Elevation, 765 ft."	35 40 05.5	80 28 07.9

Geographic positions along Southern Railway from Salisbury to Young triangulation station.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Salisbury, 1 mile northwest of; Southern Railway crossing, center of track	35 40 34.5	80 28 49.8
Salisbury, 2.3 miles northwest of; road crossing, center of track	35 40 55.2	80 30 05.7
Majolica station, road crossing, center of track	35 41 42.0	80 32 19.5
Majolica station, 0.6 mile northwest of; second-class road crossing, center of track	35 42 00.3	80 32 49.1
Eight-mile siding, 1.6 miles southeast of; road crossing, center of track	35 42 21.5	80 33 40.7
Eight Mile Siding, road crossing at, center of main track.	35 42 35.3	80 35 14.9
Second Creek, at Southern Railway bridge over, center of creek	35 42 50.8	80 35 53.4
Barber Junction, 1 mile southeast of; road crossing, center of track	35 43 12.4	80 37 36.4
Barber Junction, crossing of W. N. C. R. R. and Carolina Midland Railroad, center of track	35 43 28.9	80 38 34.6
Young triangulation station, United States Coast and Geodetic Survey, on Youngs Mountain in Rowan County, 1 mile north of Barber Junction, Southern Railway. Station mark: A bottle underground. Reference marks: Granite posts set north, south, east, and west of center and each 6 feet distant	35 44 14.36	80 38 51.12

NORTH CAROLINA.

PRIMARY TRAVERSE.

MECKLENBURG AND UNION COUNTIES.

CHARLOTTE 15-MINUTE QUADRANGLE.

The following geographic positions were established in 1905 by Mr. C. B. Kendall: The line starts from adjusted position, center of bridge over Catawba River, 1.5 miles east of Belmont, and runs eastward along Southern Railway to Charlotte; thence along wagon roads east and south near the border of the quadrangle and connects with adjusted position 1.6 miles east of Marvin Church.

Geographic positions along the Southern Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Belmont, center of bridge 1.5 miles east of	35 14 07.9	81 00 38.7
Juneau, pike crossing 1.1 miles west of	35 13 41.8	80 56 45.4
Juneau, pike crossing	35 13 35.9	80 56 10.8
Juneau, 1.1 miles east of; 400 feet south of bridge over railway, at junction of roads, iron post stamped "Prim. Trav. Sta. No. 33, 1905"	35 13 23.2	80 54 45.1
Road crossing	35 13 20.2	80 52 49.1
Charlotte, road crossing 0.75 mile west of	35 13 19.8	80 51 47.7
Road crossing	35 13 30.5	80 51 21.6
Charlotte, northwest corner of court-house, in west wall, aluminum tablet stamped "Prim. Trav. Sta. No. 34, 1905"	35 13 31.1	80 50 43.1
Charlotte, North Tryon street, road crossing overhead	35 14 13.8	80 49 47.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Charlotte, four corners 1.5 miles northeast of, at end of street-car track	35 13 18.7	80 49 18.8
T road north	35 13 13.0	80 48 39.8
Crossroads, 40 feet northeast to bridge, 20 feet south to bridge	35 13 08.9	80 47 52.7
Old Chester, at southwest corner of A. M. Wallace's store, iron post stamped "Prim. Trav. Sta. No. 35, 1905"	35 12 42.1	80 45 38.7
Forks of road, 10 feet south to cedar tree, 10 feet west to elm tree	35 12 09.7	80 45 38.8
Sardis, forks of road 1 mile north of; 50 feet west to telephone pole, 60 feet east to telephone pole painted "752"	35 10 55.8	80 45 31.4
Four corners, 50 feet southwest to railway crossing, 80 feet northeast to large oak	35 09 27.2	80 44 58.8
McAlpin Creek, bridge over	35 08 53.6	80 44 44.2
T road south, 25 feet east to J. P. Hunnicut's mail box	35 08 08.7	80 44 15.3
Matthews, three corners at	35 06 57.6	80 43 21.7
Matthews, 50 feet east of Heath & Reed's store, iron post stamped "Prim. Trav. Sta. No. 36, 1905"	35 06 59.7	80 43 16.4
Matthews, forks of road 0.5 mile south of; 70 feet south to corner of house	35 06 30.0	80 43 35.3
Fivemile Creek, center of bridge over	35 06 01.4	80 43 57.8
Four corners, 40 feet west to oak, 50 feet southeast to peach	35 04 52.1	80 43 50.0
County line post at corner Sandy Ridge, Vance, Providence, and Morning Star townships	35 03 59.3	80 48 43.3
Forks of road, 40 feet south to clump plum bushes, 40 feet west to oak	35 03 34.7	80 43 37.0
T road south, 40 feet southeast to apple tree, 60 feet west to pine stump	35 03 23.3	80 44 06.6
Gin, four corners 150 feet north of	35 02 06.8	80 44 31.3
Weddington Church at Wardlaw, crossroads opposite	35 01 17.3	80 45 46.7
Wardlaw, T road west 0.75 mile south of	35 00 41.0	80 45 57.7
Marvin, four corners at church 1.6 miles east of	34 59 18.9	80 46 31.8

CABARRUS AND MECKLENBURG COUNTIES.

MATTHEWS QUADRANGLE.

The following geographic positions were determined by primary traverse in 1905, by Mr. C. B. Kendall. The line starts from an adjusted position near northeast corner of Charlotte 15-minute quadrangle, follows highways eastward, and connects with primary traverse station No. 798.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Second-class road north, 10 feet east to oak painted "774"	35 13 25.7	80 44 42.7
Madge post-office, 4 corners, 30 feet south to stone painted "790"	35 13 23.3	80 43 30.6
T road north	35 13 43.8	80 43 38.4
Four corners, 15 feet southwest to Alex. Morris's mail box	35 14 29.9	80 41 51.2
Roberson's Church, forks of road 100 feet east of store	35 14 13.6	80 40 11.7
Forks of road on top of hill	35 14 22.0	80 39 21.7
Four corners, 10 feet southwest to oak	35 14 10.2	80 38 11.6
Forks of road, 90 feet northeast to oak	35 14 53.3	80 37 42.8
Four corners, 600 feet south of sawmill	35 15 15.8	80 37 05.1
Pioneer Mills post-office, forks of road	35 15 37.8	80 35 19.7
Pioneer Mills, 0.75 mile east of; at southwest corner of intersection of roads, iron post stamped "699 ADJ, 1903"	35 15 47.0	80 34 35.8
Four corners, 30 feet southwest to double dogwood tree	35 15 53.5	80 33 36.5
Carriker, 4 corners, 0.5 mile south of; 15 feet west to milepost marked "Concord 13 miles"	35 14 55.9	80 32 52.5
Four corners at head of small stream	35 14 31.2	80 31 15.0
Furrs post-office, 1.9 miles south of; Charlotte-Albemarle and Concord-Monroe roads, intersection of; iron benchmark post stamped "Prim. Trav. Sta. No. 798"	35 14 58.7	80 30 06.9

CHOWAN, GATES, HERTFORD, PASQUOTANK, AND PERQUIMANS COUNTIES.

ELIZABETH CITY, HOBBSVILLE, OKISKO, ROSEMEAD, WINTON, AND WOODLAND QUADRANGLES.

The following geographic positions were determined from primary traverse run in the spring of 1905, by Mr. C. B. Kendall, field assistant. The line starts from United States Coast and Geodetic Survey position of cupola of court-house at Elizabeth City, follows Norfolk and Southern Railway to Okisko; thence by wagon road to Ryland; thence northwest to Eure; thence by Atlantic Coast Line Railway across Chowan River; thence by wagon road southeast to near southeast corner of Winton quadrangle; thence west, north, and east along border of quadrangles to near northeast corner of Hobbsville quadrangle, thence southeast to starting point.

PASQUOTANK COUNTY, ELIZABETH CITY QUADRANGLE.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Elizabeth City court-house cupola (United States Coast and Geodetic Survey)	36 18 01.6	76 13 21.1
Milepost 45, road crossing 400 feet west of; Norfolk and Southern	36 18 12.7	76 14 15.9
Elizabeth City, in southeast corner of fence opposite southeast corner of court-house, iron post stamped "Prim. Trav. Sta. No. 15, 1905"	36 18 01.2	76 13 21.0

CHOWAN, GATES, AND PERQUIMANS COUNTIES, HOBBSVILLE QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Church, forks of road west of, 5 feet north to signpost painted "16.4."	36 16 46.8	76 31 09.3
Belvidere, corner of Rufus White's porch, southeast corner of, iron post stamped "Prim. Trav. Sta. No. 2, 1905."	36 16 08.1	76 32 10.6
T road south, 1,200 feet west of river, 25 feet to signpost marked "Belvidere ½ mile, Suffolk 39 miles"	36 16 05.7	76 32 58.4
T road east, 5 feet northeast to signpost marked "Hertford 10 miles, Belvidere 1½ miles, Suffolk 38 miles"	36 16 35.0	76 34 03.6
Cemetery, forks of road 200 feet west of, 40 feet north to pine, 20 feet west to water oak	36 16 39.8	76 35 37.6
T road south, 15 feet southwest to post, 10 feet northwest to rail fence	36 16 50.0	76 36 34.0
Ryland, railway crossing 75 feet south of station	36 16 33.6	76 37 47.8
Ryland, at northeast corner of Ward & Spivy's store, 142 feet west of railway crossing, 30 feet south of wagon road, iron post stamped "Prim. Trav. Sta. No. 3, 1905"	36 16 32.9	76 37 49.2
Gin, 4 corners at, 25 feet southwest to signpost marked "Belvidere 8 miles, Emmons Ferry 1 mile"	36 15 55.7	76 39 18.8
Chowan, T road south at	36 16 00.4	76 40 05.9
T road southeast, 20 feet east to corner of fence, 30 feet south to well	36 17 09.4	76 39 38.6
T road east, 200 feet south to forks northeast, 30 feet northeast to pine, 25 feet northwest to fence corner	36 18 31.6	76 39 15.0
Four corners, 25 feet south to rail fence, 40 feet north to rail-fence corner	36 19 11.5	76 39 27.2
T road north, 50 feet east to T road south, 15 feet northeast to corner wire fence, 40 feet north to oak tree	36 20 34.1	76 39 22.2
Carter, 4 corners at	36 21 27.6	76 41 04.1
T road north, 10 feet south to rail fence, 50 feet west to hickory tree	36 21 44.1	76 41 59.0
Road forks to southwest, 20 feet west to cedar, 10 feet east to rail fence	36 22 03.2	76 43 28.7
Gatesville, road forks 1 mile southeast of, 25 feet southeast to signpost	36 23 35.9	76 44 23.7
Gates, T road west 1½ miles east of; 8 feet west to signpost "*Gates 1½ miles*"	36 29 57.4	76 44 39.4

CHOWAN, GATES, AND PERQUIMANS COUNTIES, HOBBSVILLE QUADRANGLE—continued.

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T road northwest, 20 feet west to corner of fence	36 30 30.4	76 43 21.9
Schoolhouse, road forks at, 20 feet east to signpost "Sunbury 10 miles"	36 31 06.7	76 41 56.7
Second-class T road east, 20 feet southeast to corner of wire fence	36 31 51.1	76 40 35.4
Four corners, 15 feet southwest to signpost, "Somerton 5 miles, Sunbury, 8 miles	36 32 31.2	76 40 16.3
Second-class T road south	36 31 54.6	76 39 03.4
Wiggins crossroads, four corners at schoolhouse 1 mile north of	36 31 47.6	76 38 28.6
Wiggins crossroads, at southwest corner of C. C. Savage's store, iron post stamped "Prim. Trav. Sta. No. 12"	36 31 06.5	76 38 14.3
Wiggins, T road east 1.25 miles south of; 50 feet northeast to persimmon tree	36 30 05.8	76 37 56.2
Road forks south and east, 5 feet southeast to gatepost	36 29 45.3	76 37 03.8
Savage, railway crossing 500 feet north of station	36 29 24.6	76 35 21.9
Savage, 1 mile east of; at junction of roads, iron post stamped "Prim. Trav. Sta. No. 13, 1905"	36 29 08.9	76 34 35.5
Road forks east and southeast, 20 feet north to fence, 50 feet east to fence	36 28 24.7	76 33 54.1
Four corners, 20 feet west to corner wire fence, 30 feet northeast to corner rail fence	36 27 30.8	76 33 21.1
Acorn Hill, road forks 600 feet north of; 150 feet south to bridge	36. 26 26.1	76 32 44.2
Second-class T road east, 10 feet east to post planted in ground	36 25 35.7	76 32 22.9
Second-class T road east, 25 feet northeast to rail fence	36 24 30.9	76 32 29.2
T road west, 40 feet northwest to maple tree, 25 feet southwest to corner rail fence	36 23 41.5	76 32 43.7
Sandy Cross, in southeast corner of intersection of crossroads, at northwest corner of vacant store, iron post stamped "Prim. Trav. Sta. No. 14, 1905"	36 22 07.9	76 33 11.2

Geographic positions along highways from Niconor to Belvidere.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Whetstone, 4 corners at	36 19 10.8	76 29 13.8
Store, road forks at, 10 feet northeast to signpost "Sandy Cross, 5 miles, Belvidere, 4¼ miles"	36 19 08.1	76 30 17.1
White Church, second-class crossroads at	36 18 22.6	76 31 26.1
White Church, road forks 500 feet north of	36 17 16.9	76 31 55.1
B. M. No. 2	36 16 08.1	76 32 10.6

PASQUOTANK AND PERQUIMANS COUNTIES, OKISKO QUADRANGLE.

Geographic positions along the Norfolk and Southern Railway between Elizabeth City and Okisko.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Norfolk and Southern and Suffolk and Carolina Railroad crossing	36 17 53.7	76 15 00.9
Harris Siding, road crossing	36 17 36.1	76 15 51.9
Second class road crossing	36 17 22.2	76 16 32.1
Pasquotank station, road crossing 125 feet southwest of	36 16 03.4	76 20 20.0
Okisko station, road crossing 100 feet northeast of	36 15 38.5	76 21 32.0

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Perry's store, T road at, 34 feet northwest to nail in sycamore tree, 28 feet southwest to nail in post	36 16 41.3	76 21 53.8
Forks of road at west edge of swamp, 50 feet west to sign tree, 40 feet north to cypress tree	36 16 56.9	76 23 19.1
Parkville, 700 feet southeast of station; at east edge of Desert road at Junction; iron post stamped "Prim. Trav. Sta. No. 1, 1905"	36 17 30.9	76 23 58.2
T road west, 20 feet east of bridge	36 17 04.2	76 24 31.9
Milepost, second-class T road west, 1,000 feet northeast of	36 16 18.1	76 25 29.3
T road southeast at south edge of swamp, 25 feet east to gum tree painted, 60 feet south to pine tree	36 15 39.0	76 26 18.0
White's store, T road northeast at	36 14 57.1	76 27 10.2
T road southwest, 15 feet to oak tree painted, 40 feet northeast to rail fence	36 15 37.1	76 28 31.9
T road north, 10 feet north to post painted, 20 feet south to wire fence	36 16 14.4	76 29 50.1

Geographic positions along the Suffolk and Carolina Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Sandy Cross; railway crossing 1 mile east of	36 21 30.8	76 32 22.8
Milepost 17, road crossing 450 feet east of	36 20 29.6	76 29 55.7
Niconor, road crossing 150 feet east of	36 19 56.0	76 28 49.2
Tram road, switch block	36 17 44.4	76 24 41.6
B. M. No. 1	36 17 30.9	76 23 58.2
Milepost 9, road crossing 100 feet east of	36 17 46.6	76 22 27.7
Crossing of railways, road crossing just east of	36 18 27.8	76 16 54.3

BERTIE AND HERTFORD COUNTIES, ROSEMEAD QUADRANGLE.

Geographic positions along highways on north border of quadrangle.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T road west, 15 feet southwest to telephone pole, 10 feet east to rail fence	36 14 50.8	76 46 01.3
T road south, 20 feet southeast to signpost, reads "Colerain 5 miles, Harrellsville 5 miles"	36 14 52.3	76 47 40.7
Four corners, 1,300 feet west of railway, 30 feet northeast to signpost, 35 feet northwest to gum tree	36 15 05.4	76 49 16.3
Four corners at store and sawmill	36 14 23.0	76 50 01.5
Road forks south and east, 25 feet southeast to signpost, 30 feet west to gum tree	36 13 28.4	76 51 00.9
Trapp crossroads	36 12 25.3	76 52 08.7
Road forks to south, 20 feet north to rail fence	36 12 30.2	76 53 06.8
T road south, 50 feet west to oak tree, 40 feet southeast to wire fence	36 12 49.0	76 53 59.5
T road south, at east edge of Powellsville, 40 feet southeast to signpost, 25 feet north to door of store	36 13 25.0	76 55 33.2
Powellsville, northeast corner of porch to store of J. C. Britton; iron post stamped "Prim. Trav. Sta. No. 6, 1905"	36 13 34.0	76 55 57.6
Second-class road to north	36 13 38.4	76 56 53.6
Road forks, 700 feet west of swamp, 20 feet north to pine stump, 50 feet east to rail fence	36 13 40.7	76 58 12.7
T road north, 30 feet northeast to signpost, reads "Hexlena 4 miles, Olaski 6 miles"	36 13 10.5	76 59 18.6
Church, T road north	36 12 52.9	77 00 03.2
Williford schoolhouse, at southwest corner of; iron post stamped "Prim. Trav. Sta. No. 7"	36 12 18.3	77 01 51.0

BERTIE, GATES, AND HERTFORD COUNTIES, WINTON QUADRANGLE.

Geographic positions along highways between Gatesville and Gates station.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Gatesville, road forks north and northwest 2 miles northwest of, 15 feet to signpost reads, "Gatesville 2 miles, Suffolk 28 miles"	36 25 38.7	76 45 31.8
Old store, four corners at, 3 miles northwest of	36 26 13.7	76 45 31.1
Buckland, T road north	36 28 34.3	76 45 43.5
Gates station, crossing of road and railway, 350 feet south of	36 30 09.2	76 46 08.9

BERTIE, GATES, AND HERTFORD COUNTIES; WINTON QUADRANGLE—continued.

Geographic positions along highways between Gatesville and Eure.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Gatesville, corner of Main and Courtland streets	36 24 13.7	76 45 07.0
Gates County court-house, in south wall at east side of entrance; aluminum tablet stamped "Prim. Trav Sta. No. 4, 1905"	36 24 13.9	76 45 10.5
T road north, 30 feet northeast to rail fence	36 24 23.2	76 46 07.8
Four corners, 20 feet northeast to signpost, "Suffolk 30 miles, Surem Creek 2 miles," 40 feet southwest to corner yard fence	36 24 39.5	76 47 55.9
Crossroads, 35 feet south to signpost "Gatesville 5 miles," 50 feet north to oak tree	36 25 14.5	76 49 26.6

Geographic positions along the Atlantic Coast Line Railway between Eure and Tunis.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Eure, 400 feet south of station; railway crossing	36 25 41.4	76 51 06.6
Eure, railway crossing 1 mile southwest of	36 25 06.8	76 51 44.9
Center of trestle	36 23 58.2	76 52 45.5
Chowan River, center of draw to bridge over	36 23 10.9	76 53 14.7
Tunis, 1 mile southwest of; road crossing	36 22 23.9	76 53 43.7

Geographic positions along highways between Tunis and Newsom's store.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Crossroads, 25 feet northwest to gum tree, 30 feet southwest to corner rail fence	36 21 40.7	76 51 28.9
Four corners, 30 feet southeast to fence corner, 25 feet northeast to fence corner	36 21 19.0	76 50 10.4
Philonds, four corners	36 20 46.7	76 48 41.4
T road northeast, 30 feet southeast to corner of rail fence, 30 feet southwest to corner of rail fence	36 20 11.1	76 48 15.8
Second-class road to northeast	36 19 20.6	76 47 48.2
Harrellsville, four corners, intersection of streets	36 18 10.8	76 47 35.0
Harrellsville, railway crossing 1 mile southeast of	36 17 45.6	76 46 31.8
Mount Pleasant Church, forks of road	36 17 17.5	76 46 27.3
T road east, 20 feet northeast to fence corner, 10 feet northwest to telephone pole	36 16 16.9	76 46 25.6
T road leading to harbor, at southwest corner of Newsom's store; iron post stamped "Prim. Trav. Sta. No. 5, 1905"	36 15 41.3	76 46 04.9

BERTIE, GATES, AND HERTFORD COUNTIES, WINTON QUADRANGLE—continued.

Geographic positions along highways between Como and Gates station.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Como, road forks, 2 miles northeast of, 40 feet south to pine, 80 feet east to pine	36 30 46.8	76 59 19.2
Second-class road forks to northwest, 15 feet south to corner of rail fence	36 31 21.3	76 58 03.0
Riddicksville, T road southeast, 40 feet south to chimney, 80 feet west to gate	36 31 39.3	76 56 21.8
Mannys Ferry, east landing	36 31 43.6	76 54 44.4
Mannys Ferry, four corners, 1 mile southeast of	36 31 13.8	76 54 01.2
T road south, northwest of Topsy, 10 feet north to fence, 30 feet southwest to fence	36 30 39.4	76 52 52.5
Topsy, in angle at forks of road near store; iron post stamped "Prim. Trav. Sta. No. 10, 1905"	36 30 13.8	76 52 18.0
Church, T road north, 700 feet east of	36 30 23.6	76 50 48.0
T road north, 25 feet south to gate, 30 feet northeast to cedar	36 30 14.4	76 49 45.1
Four corners, 20 feet east to signpost, reads "Gatesville 10 miles," 30 feet west to gum tree	36 30 08.1	76 48 37.7
Second-class T road east	36 30 08.9	76 47 35.8
Four corners, 25 feet west to persimmon tree, 60 feet southeast to oak	36 30 03.8	76 46 40.1
Gates, at northeast corner of C. R. Hinton's house; iron post stamped "Prim. Trav. Sta. No. 11, 1905"	36 30 13.6	76 46 07.9
Gates, railway crossing, 350 feet south of station	36 30 09.2	76 46 08.9

HERTFORD COUNTY, WOODLAWN QUADRANGLE.

Geographic positions along highways between Earleys and Como.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Second-class road to northwest 200 feet south of Spring Branch, 20 feet southwest to cedar, 25 feet southeast to oak	36 13 11.3	77 01 53.5
Earleys, railway crossing	36 15 23.6	77 01 39.6
Newsonville, four corners	36 16 57.4	77 01 29.3
Four corners, 40 feet southwest to old well, 40 feet northwest to plank fence	36 18 25.7	77 01 30.2
Union, nail in root of tree at junction Main street and Windsor road	36 20 02.8	77 01 26.4
Union, four corners 1 mile north of; 25 feet southwest to corner of fence, 35 feet southeast to corner fence	36 20 57.3	77 01 22.4
Bridge, forks of road 0.25 mile north of	36 22 28.9	77 01 39.8
Junction of Murfreesboro-Union road with road leading south, iron post stamped "Prim. Trav. Sta. No. 8, 1905"	36 23 09.5	77 03 12.3
Mapleton, forks of road 3 miles southwest of; 15 feet to signpost reads, "Murfreesboro 6 miles, Mapleton 3 miles"	36 23 56.4	77 02 31.3

HERTFORD COUNTY, WOODLAWN QUADRANGLE—continued.

Geographic positions along highways between Earleys and Como—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Mapleton, forks of road 0.75 mile south of; 25 feet to signpost reads, "Murfreesboro 5 miles, Winston 6 miles".	36 25 05.3	77 01 37.8
Mapleton, five corners	36 25 38.4	77 02 03.2
Second-class road to east, 1 mile north of Mapleton, 40 feet west of wire fence, 30 feet east to old pine stump	36 26 25.5	77 02 12.7
Hills ferry, north landing	36 27 21.0	77 02 35.7
Forks of road west and south, 20 feet north to telephone pole, 40 feet south to black gum tree	36 28 33.8	77 02 16.3
T road east, 25 feet northeast to sycamore tree, 25 feet south to sweet gum tree	36 29 27.3	77 01 13.6
Como, at southeast corner of G. C. Picot's store, iron post stamped "Prim. Trav. Sta. No. 9, 1905"	36 30 05.6	77 00 26.3

JOHNSTON, SAMPSON, AND WAYNE COUNTIES.

FOUROAKS QUADRANGLE.

The following geographic positions were determined by primary traverse run in 1905 by Mr. C. B. Kendall, field assistant. The line starts from an adjusted position at Pinelevel and follows highways near border of quadrangle and closes at starting point. Another line starts near southeast corner of quadrangle, runs east, and is tied to an adjusted position at Dudley.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Pinelevel station, Southern Railway	35 30 45.3	78 14 37.1
Pinelevel, 150 feet southwest of station, at northeast corner of Z. Taylor's store, iron post stamped "Prim. Trav. Sta. No. 16, 1905"	35 30 45.0	78 14 38.8
Pinelevel, railway crossing, 1.75 miles southwest of	35 29 34.8	78 15 34.0
Stream, forks of road south of, 20 feet north to gum tree, 30 feet south to fence	35 29 27.4	78 16 11.0
Forks of road, east and southeast	35 29 45.8	78 17 32.7
Four corners	35 29 58.0	78 18 27.3
Crossing, Atlantic Coast Line Railway	35 30 19.1	78 19 28.4
Smithfield, in northwest corner of court-house, bronze tablet stamped "Prim. Trav. Sta. No. 17, 1905"	35 30 41.8	78 20 47.9
Bridge, forks of road 0.25 mile west of	35 30 58.8	78 21 24.4
T road south, 10 feet south to bridge	35 31 09.0	78 22 28.4
Smithfield, 2 miles west of; at northeast corner of old store at junction of roads, iron post stamped "Prim. Trav. Sta. No. 18, 1905"	35 31 11.9	78 23 10.8

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Sawmill, forks of road near	35 30 19.2	78 24 14.1
White Church, T road northwest at	35 29 51.2	78 25 00.2
T road north, 20 feet west to corner fence, 20 feet south to fence	35 29 15.9	78 25 39.6
Store, forks of road	35 28 31.3	78 27 27.3
Old Spilond post-office, inside of yard at southeast corner of Lassiter's store, iron post stamped "Prim. Trav. Sta. No. 19, 1905"	35 29 17.2	78 28 34.3
Church, forks of road	35 29 23.9	78 29 24.2
T road northwest, 30 feet northwest to gate, 15 feet northeast to stump	35 29 53.6	78 29 49.4
Junction of telephone lines, T road southwest at	35 29 54.5	78 30 23.8
Clearing, forks of road at southeast corner of, 15 feet west to telephone pole	35 29 35.1	78 31 15.1
Benson, 8 miles northwest of; in angle of road at junction, iron post stamped "Prim. Trav. Sta. No. 20, 1905"	35 29 18.6	78 32 10.3
T road north, 40 feet east to fence, 40 feet south to hickory	35 28 10.0	78 33 12.3
T road southeast, 60 feet east to oak, 40 feet south to hickory	35 26 54.4	78 33 25.7
Bonnir, four corners	35 25 46.9	78 33 47.1
T road west, 15 feet northwest to corner plank fence, 10 feet southwest to oak	35 24 28.5	78 33 25.0
Benson, at northeast corner of Boykin Hotel, 250 feet southwest of station, iron post stamped "Prim. Trav. Sta. 21, 1905"	35 22 50.1	78 32 52.3
Forks of road, 15 feet south to fence, 10 feet north to oak stump	35 22 11.5	78 31 41.5
T road north, 30 feet north to signpost, 20 feet south to telephone pole	35 21 51.2	78 30 31.6
Four corners	35 21 09.1	78 30 26.8
Four corners, 30 feet east to pine, 10 feet south to fence	35 20 10.8	78 29 48.1
Four corners, at Burnt Store	35 19 32.1	78 29 45.1
Four corners, 15 feet southwest to fence corner, 10 feet southeast to fence corner	35 18 43.1	78 30 36.1
Four corners, 35 feet southeast to gate, 10 feet north to corner of plank fence	35 18 05.3	78 31 39.9
Forks of road, 600 feet west of sawmill	35 17 28.9	78 32 24.5
Forks of road, 20 feet northwest to front gate, 40 feet south to hickory	35 16 40.4	78 32 57.1
Mingo post-office, 600 feet east of; at junction of roads, iron post stamped "Prim. Trav. Sta. No. 22, 1905"	35 16 14.2	78 33 11.0
Mingo, 1 mile east of; bridge at forks of road	35 15 58.1	78 32 13.9
Four corners, 25 feet northwest to oak, 40 feet east to pine snag	35 15 26.5	78 31 45.5
T road south, 30 feet south to corner of fence and signpost "Clinton 22 miles"	35 14 46.8	78 30 31.1
T road south, 15 feet south to bridge	35 14 27.3	78 29 53.5

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Forks of roads, 70 feet east to oak, 5 feet north to fence	35 14 13.8	78 28 09.2
Timothy, forks of road, 0.25 mile northwest of	35 13 32.9	78 27 35.9
Four corners, 15 feet northeast to corner of plank fence, 20 feet northwest to corner rail fence	35 12 58.2	78 25 59.0
Rosin Hill post-office, at northwest corner of J. McPhail's store, iron post stamped "Prim. Trav. Sta. No. 23, 1905".	35 12 31.8	78 24 54.8
Oak Grove Church, four corners 0.5 mile east of	35 13 21.0	78 23 44.9
Great Coharie crossing, forks of road	35 13 10.2	78 22 14.6
T road south, 25 feet east to signboard "Clinton 19 miles".	35 13 47.5	78 21 53.8
Beaverdam shoolhouse, forks of road	35 13 43.1	78 20 49.3
Newton Grove, 1 mile southeast of; forks of road	35 14 29.3	78 20 19.6
Forks, 10 feet east to signpost "Dobbinsville 4 miles, Goldsboro 24 miles"	35 15 05.8	78 17 44.4
Intersection of roads, iron post stamped "Prim. Trav. Sta. No. 29, 1905"	35 15 40.6	78 16 59.7
Falling Creek, 0.25 mile north of; three corners, 15 feet north to signpost "Goldsboro 22 miles," 15 feet south to fence	35 16 27.9	78 16 41.4
T road west, 25 feet northwest to gate, 20 feet southwest to fence corner	35 17 06.0	78 16 41.5
Thornton's store, T road west	35 17 35.8	78 16 51.9
T road east	35 18 28.1	78 16 57.5
White Church and store, forks of road	35 19 14.2	78 16 43.0
Forks of road, 15 feet north to pine, 100 feet east to second-class T road south	35 19 41.2	78 15 06.6
Cemetery, forks of road, 300 feet east of	35 19 56.8	78 14 01.5
Cox's mill, forks of road	35 20 04.4	78 12 55.2
Cox's mill, T road east 1 mile northeast of	35 20 56.6	78 12 26.6
Forks of road, second-class road to east	35 22 13.3	78 11 48.0
Richardson's Bridge, forks of road 700 feet east of	35 22 34.7	78 11 43.8
Richardson's Bridge, 1.75 miles northeast of; on east edge of road at junction, iron post stamped "Prim. Trav. Sta. No. 32, 1905"	35 24 03.6	78 10 56.8
Bridge, forks of road 40 feet east of	35 24 19.8	78 12 53.2
Forks of road, 20 feet east of signpost "Princeton 6 miles," 10 feet north to fence corner	35 25 46.9	78 14 46.0
Forks of road, 20 feet east to gate, 20 feet west to wire fence	35 26 52.6	78 14 23.1
Forks of road, 10 feet east to wire fence, 35 feet west to yard fence	35 27 46.1	78 14 31.6
T road south, 40 feet southwest to fence corner, 40 feet north to oak	35 28 57.9	78 14 39.7
Carolina Midland Railroad crossing, at station	35 29 34.7	78 15 33.9

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
WAYNE COUNTY.	° ′ ″	° ′ ″
Schoolhouse, T road south at	35 15 42.6	78 16 19.6
Starlight, four corners at schoolhouse 0.25 mile east of	35 15 59.1	78 15 29.1
Ranors Mill, bridge over mill tail	35 16 34.1	78 14 19.8
Eureka Church, four corners	35 16 12.1	78 13 40.5
Schoolhouse, T road south 200 feet east of	35 15 55.8	78 12 51.6
T road southwest	35 15 57.2	78 11 43.8
Corbett Hill schoolhouse, at northeast corner iron post stamped "Prim. Trav. Sta. No. 30, 1905"	35 15 26.4	78 10 44.6
T road south, 30 feet west to oak, 30 feet north to fence.	35 15 03.7	78 09 56.6
Mount Carmel Church, T road north 0.5 mile east of	35 15 06.1	78 08 08.1
Thorofare Swamp, T road north 0.25 mile west of	35 15 12.7	78 07 07.9
Forks of road, 70 feet southwest to double oak, at corner of fence	35 15 20.6	78 05 43.8
Dudley, forks of road 1 mile west of	35 16 06.4	78 03 24.7
Dudley, at northeast corner of J. Aldridge's store, iron post stamped "Prim. Trav. Sta. No. 31, 1905"	35 16 03.6	78 02 13.3
Dudley, south end of station	35 15 58.2	78 02 13.0

OHIO.

PRIMARY TRAVERSE.

SUMMIT COUNTY.

AKRON QUADRANGLE.

Additional control for this quadrangle was obtained in December, 1904, by Mr. J. R. Ellis, topographic aid, who ran a line from the Erie Railroad station at Barberton west along that railroad 1.5 miles, thence north along highways to West Richfield, and tied to Primary Traverse Station 106 A at that place.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Barberton, Barberton Inn, at right side of main entrance stairway to, in face of support to veranda, aluminum tablet stamped "Prim. Trav. Sta. No. 50, 981 Cleveland" (elevation 981.260)	° ′ ″ 41 00 47.0	° ′ ″ 81 36 39.7
Barberton, Erie station	41 01 13.2	81 36 36.5
Barberton, road crossing 1½ miles west of (Erie Railroad).	41 01 08.6	81 38 19.3
Loyal Oak, crossroads at, 46 feet northeast to guidepost, 47 feet southeast to northwest corner of porch to hotel.	41 03 01.6	81 38 16.9
Norton and Copley townships, line between, T road west, 13 feet southwest to south end of culvert, 33 feet northwest to apple tree at corner of fence	41 03 43.9	81 38 16.5

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Miksch's mills, forks of road north of, 30 feet east to corner of yard fence, 60 feet south to guidepost	41 04 28.0	81 38 21.4
Copley, in southwest corner of Disciples Church, aluminum tablet stamped "Prim. Trav. Sta. No. 51, 1049, Cleveland" (elevation 1,049.163)	41 05 58.5	81 38 39.5
Montrose, crossroads, at line between Copley and Bath townships, 39 feet southeast to cross on telegraph pole, 45 feet northwest to F. Collins's mail box	41 08 08.9	81 38 15.2
Ghent, T road west, 24 feet southeast to northwest corner of water trough, 41 feet southwest to northeast corner of porch to store	41 09 29.6	81 38 14.0
Bath High School, crossroads at, 28 feet southeast to cross on telegraph pole, 43 feet southwest to cherry tree at corner of fence	41 10 08.4	81 38 13.4
Hammonds Corners, crossroads at, 45 feet to northeast corner of portion to Bath Hotel, 39 feet northwest to guidepost	41 11 20.4	81 38 12.0
Bath and Richfield townships, crossroads at, 90 feet east to Wm. Miller's mail box, 48 feet southeast to signboard on tree	41 12 08.4	81 38 17.8
Richfield Center, forks of road 1½ miles south of, 24 feet west to Park Lee's mail box, 46 feet southeast to guide post	41 13 07.0	81 38 18.0
West Richfield, aluminum tablet stamped "Prim. Trav. Sta. No. 106 A," elevation 1,279, Cleveland, in south wall at southeast corner at stone foundation to the Carter House	41 14 24.0	81 39 20.1

ALLEN AND PUTNAM COUNTIES.

BLUFFTON QUADRANGLE.

The following geographic positions were established by Mr. J. R. Ellis in 1904. The line starts from primary traverse position at Westminster station and follows range line road (public) to primary traverse position on Findlay, Fort Wayne and Western Railroad about 3 miles east of Ottawa.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Westminster station	40 42 57.2	83 59 35.3
Westminster station, T. 4 S., R. 7 E., southeast corner sec. 1, in southeast corner of field of Joseph Craig, northwest corner of his residence bears S. 88° E., distant 62.3 feet; south rail of Erie Railroad at road crossing bears S. 6° E., distant 243.2 feet; in top of a limestone post 30 by 8 by 8 inches set 26 inches in ground, aluminum tablet stamped "Prim. Trav. Sta. No. 1"	40 42 59.9	83 59 38.9
Ts. 3 and 4 S., Rs. 7 and 8 E., secs. 1, 6, 31, and 36, at crossroads, 35 feet southeast to cross cut on corner fence post, 34 feet northeast to cross cut on corner fence post	40 43 52.0	83 59 38.8

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 3 S., R. 8 E., corner secs. 30 and 31 (west corner) at T road east, corner stone	40 44 44.5	83 59 38.8
Pittsburg, Fort Wayne and Chicago Railroad, at road crossing between ranges 7 and 8 E., between tracks, azimuth of railroad=82° 21′ 09″	40 45 13.7	83 59 38.7
T. 3 S., Rs. 7 and 8 E., corner secs. 24 and 25 (east corner), corner stone	40 45 36.7	83 59 38.8
T. 3 S., Rs. 7 and 8 E., corner secs. 13, 18, 19, and 24, corner stone	40 46 29.0	83 59 38.9
T. 3 S., Rs. 7 and 8 E., corner secs. 7, 12, 13, and 18, corner stone, at crossroads	40 47 21.1	83 59 39.2
T. 3 S., Rs. 7 and 8 E., west corner secs. 1 and 12, corner stone	40 48 13.3	83 59 39.5
Lake Erie and Western Railroad, road crossing between ranges 7 and 8 E., azimuth of railroad=229° 10′ 15″	40 49 17.4	83 59 40.1
T. 2 S., R. 7 E., northeast corner of sec. 36, in field owned by Louis Roberts, northeast corner of Roberts's residence bears S. 78° E., distant 63.3 feet; nail in telephone pole on south side of pike bears N. 12° 15′ E., distant 8.6 feet, aluminum tablet set in stone 7 by 16 by 24 inches set 20 inches in ground, stamped "Prim. Trav. Sta. No. 2"	40 49 57.7	83 59 40.8
T. 2 S., Rs. 7 and 8 E., east corner secs. 24 and 25, at T road west	40 50 51.4	83 59 40.9
T. 2 S., Rs. 7 and 8 E., east corner secs. 13 and 24, at T road east, corner stone	40 51 44.1	83 59 41.5
Rockport, crossroads at, 25 feet northeast to pump, 33 feet northwest to cross cut on telephone pole	40 52 17.5	84 00 00.0
T. 2 S., R. 7. E., quarter corner between secs. 1 and 12, at crossroads	40 53 26.8	84 00 15.8
Ts. 1 and 2 S., Rs. 7 and 8 E., corner secs. 1, 6, 31, and 36, at T road north, 24 feet southwest to cross cut on telephone pole, 30 feet northwest to arrow on corner fence post	40 54 18.8	83 59 42.7
T. 1 S., R. 7 E., corner secs. 25 and 36, at T road west, 18 feet southwest to cross on south end of culvert, 30 feet northwest to cross on corner fence post	40 55 11.4	83 59 43.1
T. 1 S., R. 7 E., in northeast corner of sec. 25 in field owned by John Keine, W. J. Luginbill's mail box bears N. 15° E., distant 39.5 feet; cross cut on third layer of stone retaining wall to culvert bears N. 87° E.; distant 14.5 feet; in top of Bedford limestone 30 by 16 by 6 inches, set 27 inches in ground, aluminum tablet stamped "Prim. Trav. Sta. No. 3"	40 56 03.6	83 59 43.8
Northern Ohio Railroad at road crossing between ranges 7 and 8 E., azimuth of railroad=246° 59′ 59″	40 56 08.9	83 59 43.6
T road south at small bridge, 18 feet southeast to cross cut on south end of bridge, 25 feet southeast to cross cut on corner fence post	40 57 48.9	84 00 01.7
Schoolhouse, Subdistrict No. 1, intersection of roads at, 18 feet southwest to south end of stone culvert, 15 feet west to cross on telephone pole	40 58 41.5	84 00 46.8
T. 1 S., R. 7 E., north corner secs. 1 and 2, at T road south, 32 feet southwest to cross on corner fence post, 45 feet southeast to cross on telephone pole	40 59 34.2	84 00 53.6

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
T. 1 N., R. 7 E., west corner secs. 25 and 36, center of road at fence east	° ′ ″ 41 00 26.7	° ′ ″ 84 00 54.8
Ottawa, 3 miles east of; in southwest corner of James Maidlow's front yard, southwest corner of Maidlow's residence bears N. 44° 30′ E., distant 46.8 feet; corner post to southwest corner of Maidlow's yard fence bears SW., distant 2 feet; in top of marble post 6 by 6 by 24 inches, set 23 inches in ground, aluminum tablet stamped "Prim. Trav. Sta. No. 4"	41 00 54.1	83 59 48.9
Findlay, Fort Wayne and Western Railroad road crossing between ranges 7 and 8 E	41 01 18.2	83 59 45.3

TRUMBULL COUNTY.

BRISTOLVILLE QUADRANGLE.

The following geographic positions were obtained from primary traverse run in 1904 by Mr. J. R. Ellis from a point located at Phalanx to Mesopotamia triangulation station of the United States Lake Survey:

Geographic positions along highways.

Station.	Latitude.	Longitude.
Phalanx post-office, crossroads at; 20 feet southeast to guidepost, 18 feet west to stone in road	° ′ ″ 41 15 39.5	° ′ ″ 80 58 43.9
Phalanx post-office, Y road 0.5 mile north of; 24 feet north to cross on telephone pole, 30 feet east to cross on gatepost	41 16 12.6	80 58 38.9
T. 5 N., R. 5 W., corner to secs. 31, 32, 33, and 34	41 17 38.6	80 59 01.1
Crossroads, 40 feet northeast to cross on telephone pole, 40 feet northwest to cross on fence post	41 18 30.3	80 59 01.0
T road east	41 19 43.2	80 59 00.9
Crossroads at schoolhouse and corner secs. 1, 2, 3, and 4, T. 5 N., R. 5 W.; 20 feet northeast to E. F. Culp's mail box, 45 feet southeast to milk platform	41 20 21.4	80 59 00.7
T. 6 N., R. 5 W., corner stone to secs. 2 and 11 (east corner)	41 21 42.0	80 59 00.3
West Farmington, 1.5 miles southwest of; in G. A. McKay's orchard, 120 feet northeast of State road at road northeast; southwest corner of McKay's house bears N. 54° 50′ E., distant 211 feet; nail in east face of elm tree on west side of road bears N. 27° 55′ W., distant 48.7 feet; iron post stamped "Prim. Trav. Sta. No. 31"	41 22 37.1	80 59 45.4
Pennsylvania Railroad at road crossing	41 24 09.1	80 59 24.5
Bundysburg, large flag pole at road intersection	41 25 17.9	81 00 17.4
Mesopotamia triangulation station, 0.12 mile east of west line and 0.5 mile south of center line of township of Mesopotamia, and 4 miles east of village of Middlefield. Station mark: A stone post under ground, with stone post over it as a surface mark. Reference: Three stone posts, one N. 23° 23′ W., distant 102.6 meters; one N. 9° 51′ E., distant 96 meters; and one S. 20° 40′ E., distant 129.4 meters from geodetic point	41 26 59.75	80 59 53.15

HOCKING, PICKAWAY, AND ROSS COUNTIES.

CHILLICOTHE QUADRANGLE.

The following geographic positions were determined by primary traverse in 1904 by Mr. J. R. Ellis, topographic aid. The line starts from northwest corner of quadrangle and follows east along public highways to Stringtown; thence south near east border of quadrangle to Gillespieville; thence west to Schooley; thence northwest along Baltimore and Ohio Railroad to Chillicothe; thence north along public highway to tie point at northwest corner of quadrangle. A line was also run from Chillicothe south along Portsmouth pike to Waller.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Scioto River, east end of bridge over	39 28 21.9	82 59 43.1
Scioto River bridge, nail in hub at T road west 1 mile east of; 24 feet east to cross on telephone pole, 27 feet northwest to D. W. Kellenberger's mail box	39 28 20.9	82 58 43.8
Corner secs. 1, 2, 35, and 36; 15 feet west to stone between Ross and Pickaway counties; 35 feet southeast to cross cut on rail fence	39 28 45.6	82 58 42.4
Nash's Corners, crossroads at; 33 feet southwest to Vernon Estill's mail box; 30 feet southeast to cross on corner of fence post	39 30 31.1	82 58 20.7
Nash's Corners, T road south 1 mile east of; 17 feet northeast to Manger's mail box; 18 feet northwest to cross on gatepost	39 30 29.4	82 57 15.2
Nash's Corners, T road west at small bridge 1.5 miles east of; 3 feet northwest to southwest corner of bridge; 15 feet east to southeast corner of bridge	39 30 27.9	82 56 40.7
(Azimuth of Norfolk and Western Railroad at Elmwood station=334° 44′ 45″.)		
Elmwood station, T road west about 900 feet east of; 22 feet east to cross on gatepost; 50 feet northwest to cross on telephone pole	39 30 01.6	82 55 28.0
Meade, T road northwest 1 mile southwest of; 21 feet south to cross on gatepost; 30 feet west to cross on fence post	39 29 49.0	82 53 29.1
Meade, crossroads at; 22 feet north to W. F. Anderson's mail box; 38 feet east to corner of grocery store	39 30 25.1	82 52 55.5
Meade, in west corner of schoolhouse yard; west corner of water table to schoolhouse bears N. 46° 45′ E., distant 38.3 feet; east corner of brick foundation to G. W. Greeg's residence bears S. 25° W., distant 116.3 feet; in top of sandstone 6 by 12 by 36 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 8"	39 30 18.0	82 52 40.5
Meade, T road southwest 0.75 mile southeast of; 16 feet southwest to David Polling's mail box; 21 feet north to cross on fence post at end of hedge fence	39 30 00.3	82 52 04.3
Oak Grove schoolhouse; crossroads; 37 feet north to A. J. & Guy E. Pouter's mail box; 24 feet southwest to cross on large corner fence post	39 29 43.6	82 50 56.8

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Whistler, crossroads at church; 36 feet northwest to iron fence post; 34 feet southeast to cross on telephone pole.	° ′ ″ 39 29 11.0	° ′ ″ 82 49 19.7
T. 11, R. 20, corner secs. 28, 29, 32, and 33	39 29 09.3	82 48 46.9
Whistler, T road north 1 mile east of; 36 feet northwest to George Duhrsten's mail box; 18 feet southeast to south end of easternmost culvert	39 29 07.5	82 48 13.4
T. 11, R. 20, corner secs. 27, 28, 33, and 34; at T road north; 21 feet south to cross on fence post, 30 feet north to cross on corner fence post	39 29 05.6	82 47 40.0
T. 11, R. 20, corner secs. 26, 27, 34, and 35; at T road north; 21 feet south to cross on fence post, 27 feet northwest to cross on corner fence post	39 29 02.0	82 46 33.6
Stringtown, in southwest corner of William Ballard's pasture; southeast corner of Levi Imer's store bears N. 24° W., distant 62.4 feet; cross cut on last end of stone culvert bears S. 18° W., distant 38.5 feet; in top of sandstone post 6 by 10 by 36 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 9"	39 30 03.5	82 46 27.1
T road east, 18 feet west to cross on gatepost	39 29 07.2	82 45 23.5
Adelphi, crossing Main and Concord streets; 40 feet southeast to lamppost; 36 feet northwest to telephone pole at general store	39 27 58.9	82 44 52.3
Adelphi, T road west 1 mile south of; 33 feet northwest to cross on corner fence post; 21 feet to northwest corner of stone culvert	39 26 51.2	82 45 01.7
T. 10, R. 20, corner secs. 18, 19, 23, and 24; also line between Ross and Hocking counties	39 25 28.7	82 44 38.5
Feightner, T road north at blacksmith shop; 21 feet west to southwest corner of shop; 30 feet northwest to small apple tree	39 24 45.4	82 44 48.2
Pritchard's (Tom) residence, intersection of roads; 15 feet north to cross cut on small cottonwood tree	39 23 39.0	82 43 28.4
Feightner, 2 miles south of; in northeast corner of T. B. Pritchard's front yard; northeast corner to foundation of porch of Pritchard's residence bears S. 73° 15′ W., distant 49.2 feet; nail in north face of cottonwood tree in front yard bears S. 15° E., distant 7.7 feet; in top of sandstone post 6 by 10 by 36 inches set 32 inches in ground, aluminum tablet stamped "Prim. Trav. Sta. No. 10"	39 23 36.8	82 43 28.8
T road southwest, 18 feet south to cross on corner fence post, 20 feet northeast to cross on fence post	39 22 19.2	82 43 47.9
Pike Run, T road east at; 25 feet northeast to cross on telephone pole, 25 feet southeast to corner of old store building	39 21 11.8	82 43 19.8
Pike Run, crossroads 0.75 mile south of; 18 feet northwest to cross on corner fence post; 22 feet southwest to south end of box culvert	39 20 40.3	82 43 26.6
Pike Run, intersection of roads at bridge about 1 mile west of; 10 feet east to north corner of bridge; 10 feet south to southwest corner of bridge	39 21 19.2	82 44 22.2
Haddox (George) residence, Y road east; 10 feet south to cross on board fence; 30 feet west to cross on post	39 21 37.5	82 45 41.8
Summit of hill, center of road; 30 feet north to cross on gatepost	39 21 22.6	82 45 58.4

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Tedron farm, forks of road near head of Piney Creek; 18 feet northwest to cross on fence post; 24 feet east to cross on fence post	° ′ ″ 39 21 12.6	° ′ ″ 82 46 56.5
Watson Bobbett's farm, T road north; 21 feet south to cross on rail fence	39 20 12.9	82 46 38.7
Intersection of roads, about 0.75 mile north of store; 25 feet southwest to mail box; 25 feet east to cross on corner fence post	39 18 14.6	82 46 48.1
Store, T road west 0.33 mile south of; 27 feet northwest to cross on corner fence post; 25 feet south to J. W. Cunningham's mail box	39 17 20.5	82 46 31.1
Schoolhouse, T road northwest; 21 feet south to cross on gatepost; 36 feet northeast to cross on board fence	39 16 51.7	82 46 25.2
Gillespieville, in ground owned by George Radcliff; southwest corner of Radcliff's residence bears N. 25° 45′ E., distant 98.9 feet; northeast corner of Radcliff's general store bears S. 35° W., distant 126.3 feet, in top of sandstone post 6 by 10 by 30 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 11"	39 16 01.9	82 47 24.4
Gillespieville, T road south 1 mile west of; 27 feet southwest to mail box; 35 feet southeast to cross on fence post	39 16 09.5	82 48 24.0
Gillespieville, T road north about 2 miles west of; 36 feet northeast to cross on corner fence post; 21 feet southwest to cross on walnut tree	39 16 33.8	82 49 29.7
Bridge over Walnut Creek, center of	39 16 49.2	82 50 21.9

Geographic positions along the Baltimore and Ohio Southwestern Railroad between Schooley and Chillicothe.

Station.	Latitude.	Longitude.
Schooley station, in C. E. Harness's pasture, on north side of railroad; nail in crosscut on south face of elm tree bears N. 3° 35′ W., distant 51.1 feet; north rail at center of north and south road crossing railroad, azimuth 8° 26′ 50″, distant 159.8 feet; in top of sandstone post 6 by 8 by 30 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 12"	° ′ ″ 39 15 59.0	° ′ ″ 82 52 11.0
Milepost 104, private road crossing 1,500 feet northwest of	39 16 47.9	82 53 19.5
Gravel pit, private road crossing 235 feet northwest of west end of switch	39 17 35.1	82 54 22.0
Scioto River Bridge, west end of	39 18 18.9	82 55 20.0
Chillicothe and Gillespieville pike crossing	39 18 50.7	82 56 02.2
Milepost 99, pike crossing 820 feet west of	39 19 42.4	82 57 17.3
Chillicothe, crossing Baltimore and Ohio and Norfolk and Western railroads	39 20 05.3	82 58 12.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Schoolhouse No. 2, T lane west; 22 feet east to cross on board fence, 33 feet southwest to cross on fence post	39 21 22.3	82 58 34.6
T road east, 29 feet northeast to A. J. Seney's mail box, 33 feet northeast to guidepost	39 21 50.9	82 58 33.5
Hopetown, crossroads; 26 feet northeast to C. W. Down's mail box, 50 feet northeast to southwest corner of P. H. Klatz's shoe shop	39 22 43.3	82 58 29.0
Hopetown, forks of pike 1 mile north of; 18 feet east to cross on fence post, 50 feet northwest to arrow painted on corner fence post	39 23 31.5	82 58 07.1
Hopetown, cross pikes 2 miles north of; 30 feet south to William Albright's mail box, 24 feet northwest to cross on corner fence post	39 24 27.0	82 58 30.7
Mettler (George), in northeast corner of field; on west side of pike opposite Mettler's house, northwest corner of foundation to corncrib, bears S. 22° 15′ E., distant 78.2 feet; nail in west face of black locust tree in front yard bears S. 82° 30′ E., distant 54 feet. Iron post set 40 inches in the ground, stamped "Prim. Trav. Sta. No. 13."	39 26 16.6	82 58 35.2
Road east, 28 feet southeast to David Umstead's mail box, 24 feet northeast to corner of yard fence	39 27 26.6	82 58 42.6

Geographic positions along highways from Chillicothe south to southwest corner of quadrangle.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Chillicothe, in stone floor to court-house porch on right side of main entrance to building. Aluminum tablet stamped "Prim. Trav. Sta. No. 14."	39 20 00.6	82 58 56.4
Chillicothe, crossing of Cincinnati, Hamilton and Dayton Railway and Paint street	39 19 20.9	82 58 45.2
Chillicothe and Portsmouth pikes, center of, at milepost 2 (Chillicothe)	39 18 31.2	82 57 51.6
Ludbecks Siding, crossroads west of; 24 feet east to mail box, 32 feet northwest to cross on telephone pole	39 17 53.4	82 57 12.9
Waller, T road southeast at, water trough about 2 miles north of; 27 feet northeast to Blain's mail box, 18 feet northwest to northeast corner of water trough	39 17 23.5	82 56 48.6
Waller, T road northwest; 24 feet south to cross on gatepost, 18 feet east to cross on board fence	39 16 04.1	82 57 51.6
Waller, 0.75 mile south of; in northeast corner of field owned by Joseph Deuschle, on west side Chillicothe and Portsmouth pike; nail in east face of apple tree on fence line bears N. 74° 15′ W., distant 39.3 feet; hitching ring in east face of locust tree in front of Deuschle's store bears S. 26° 15′ W., distant 262.1 feet—iron post set 36 inches in the ground, stamped "Prim. Trav. Sta. No. 15"	39 15 34.7	82 58 10.3

COLUMBIANA AND MAHONING COUNTIES.

EAST PALESTINE QUADRANGLE.

The following geographic positions were obtained from primary traverse run in 1904 by Mr. J. R. Ellis. The line starts from an adjusted position at Lisbon, runs eastward over the Pittsburg, Lisbon and Western Railroad, and ties to the Ohio-Pennsylvania State line monument No. 81, near Negley.

Geographic positions along the Pittsburg, Lisbon and Western Railroad.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Lisbon, United States Geological Survey bench mark No. 45	40 46 20.28	80 46 04.04
Lisbon, street crossing of Pittsburg, Lisbon and Western Railroad, just south of	40 46 16.5	80 45 27.4
American Pipe Co., road crossing 0.25 mile east of	40 46 02.3	80 44 08.6
Road crossing under trestle	40 45 55.8	80 42 46.5
Elkton, road crossing north and south at station	40 45 52.8	80 41 54.6
Newhouse, switch block to mine	40 46 51.8	80 41 16.7
Summit, road crossing; second crossing south of station	40 47 53.7	80 39 34.2
Rogers, road crossing 1 mile west of	40 47 38.1	80 38 37.1
Rogers, in southeast corner of Ida M. Rogers farm; on north side of Pittsburg, Lisbon and Western Railroad; southeast abutment to wagon bridge N. 9° 45′ W., distant 202.8 feet; cross on northeast corner of foundation to D. M. Millers residence bears S. 4° 40′ E., distant 644 feet; in sandstone post, aluminum tablet stamped "Prim. Trav. Sta. No. 46."	40 47 35.6	80 37 39.4
Rogers, road crossing 0.75 mile east of	40 47 42.1	80 36 58.5
Millrock station, road crossing	40 47 56.1	80 35 31.2
Private road crossing at spur	40 47 55.5	80 34 30.8
Negley, north and south road crossing at station	40 47 27.5	80 32 20.5
Ohio-Pennsylvania State line monument No. 81; stone is 25 feet east of center of north and south road	40 47 49.98	80 31 08.93

PORTAGE COUNTY.

GARRETTSVILLE QUADRANGLE.

The following geographic positions were obtained from primary traverse run in 1904 by Mr. J. R. Ellis. The line starts from an adjusted position at Mantua, Ohio, and follows the Erie Railroad east through Mahoning to Phalanx.

Geographic positions along the Erie Railroad between Mantua and Phalanx.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Mantua, road crossing north and south, Erie Railroad	41 16 52.8	81 13 28.8
Mantua, 0.33 mile east of; in southwest part of grounds of Standard Oil Co. pumping station, southwest corner of foundation to boiler building bears N. 41° 50′ E., distant 135 feet; nail in sugar maple tree bears N. 61° W., distant 35.7 feet, and is 2 feet north of Erie Railroad fence, iron post stamped "Prim. Trav. Sta. No. 29"	41 16 59.7	81 13 00.9
Mantua, road crossing 1.75 miles east of	41 16 50.6	81 11 32.4
T. 5 N., R. 7 W., quarter corner between secs. 41 and 50	41 16 51.7	81 10 58.5
Overhead road crossing near milepost 34	41 16 34.8	81 09 44.0
Hiram station, road crossing	41 16 37.4	81 08 42.9
Overhead road crossing north and south	41 16 45.1	81 07 57.9
Garrettsville, in south part of H. J. Langton's yard, southwest corner of foundation to Langton's residence bears N. 30° 45′ W., distant 129 feet; nail in cross mark on west face of cherry tree bears S. 49° 30′ E., distant 6.2 feet; iron post stamped "Prim. Trav. Sta. No. 30"	41 16 53.4	81 05 54.2
Road crossing east and west about 800 feet east of milepost 38	41 16 48.2	81 05 16.6
Road crossing east and west 0.50 mile southeast of milepost 39	41 16 46.4	81 04 02.3
Mahoning, road crossing	41 15 42.9	81 02 57.7
Milepost 42, private road crossing 130 feet east of	41 15 29.6	81 01 39.4
County line, north and south road crossing	41 15 21.5	81 00 10.8

SCIOTO COUNTY.

GREENUP QUADRANGLE.

The line starts from southeast corner of Scioto quadrangle, and follows highways south via Powellsville to Gould triangulation station. United States Coast and Geodetic Survey.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T road southwest, 30 feet west to J. Herchman's mail box; 24 feet south to cross on rail fence	38 44 30.9	82 45 47.0
Road northeast; 12 feet south to cross on fence post; 57 feet northeast to cross on sycamore tree	38 44 08.4	82 44 59.8
Cadot farm, intersection of Lyra and Wheelersburg pike, and road southeast to Powellsville, near summit of hill; 36 feet northeast to cross on fence post; 36 feet southeast to cross on fence post	38 42 59.9	82 45 21.3
J. M. Morgan's residence, intersection of roads just east of; 18 feet south to cross on picket fence	38 42 38.1	82 45 22.6
Quarter corner between sec. 28 and 32 (stone)	38 41 42.2	82 45 52.1
Knapp's (George) residence, intersection of roads at, 18 feet northeast to Knapp's mail box; 40 feet southwest to cross on large willow tree	38 40 51.5	82 45 27.3
Powellsville, about 1 mile northeast of; in orchard owned by Lewis Knapp, north corner of foundation to Knapp's residence bears S. 32° 15′ W., distant 164.5 feet; nail in cross cut in black oak tree 8 inches in diameter bears N. 86° 30″ E., distant 85.2 feet; iron bench mark post stamped "Prim. Trav. Sta. No. 24"	38 40 30.4	82 46 05.9
Powellsville, crossroads at; 24 feet southeast to Rase Bros.' mail box; 50 feet southwest to northeast corner of Rase Bros.' store	38 40 00.3	82 47 01.1
Covered bridge over Piney Creek, intersection of roads 200 feet southeast of; 18 feet north to cross on post	38 39 10.0	82 48 08.0
Stacker's (H.) farm, T road northwest at; 30 feet east to cross on beech tree, 32 feet west to cross on corner fence post	38 38 07.6	82 49 02.1
Franklin Furnace, T road west on top of hill; 1.5 miles east of; 27 feet north to cross on black-oak sapling, 40 feet west to cross on stump	38 38 34.0	82 49 17.4
Gould triangulation station (United States Coast and Geodetic Survey); on the hills east of the Ohio river 1.5 miles air line from river at Franklin Furnace landing. Station mark: Center by a pottery pyramid 3 feet below surface, above which is a sewer pipe 6 inches in diameter, filled with concrete with a nail in center. Other pieces of pipe, 4 inches in diameter, with concrete, are sunk as follows: North, true, 6.08 feet distant; south, true, 6.11 feet distant; east, true, 5.78 feet distant; west, true, a brass rod 0.25 inch in diameter, driven in smooth top of an oak stump, and surrounded by nails as follows: , distant 5.77 feet	38 38 27.6	82 49 56.7

Geographic positions along the Norfolk and Western Railroad between Franklin Furnace and Wheelersburg.

Station.	Latitude.	Longitude.
Franklin Furnace, in northeast corner of Methodist Church yard; cross on northwest corner to foundation to church bears S. 24° 25′ E., distant 26.4 feet; cross on northwest corner to foundation to public school building bears S. 85° 10′ E., distant 130.4 feet; iron bench mark post set 40 inches in the ground, stamped "Prim. Trav. Sta. No. 25"	° ′ ″ 38 38 42.2	° ′ ″ 82 50 56.0
Milepost 113, private road crossing 900 feet south of	38 39 48.8	82 51 20.7
Milepost 112, private road crossing 935 feet south of	38 40 39.8	82 51 34.0
Milepost 111, road crossing east and west 1,400 feet south of	38 41 26.4	82 51 46.2
Wheelersburg, private road crossing at old log house 2 miles south of	38 42 14.7	82 51 52.8
Wheelersburg, road crossing east and west 135 feet south of station	38 43 44.4	82 51 46.2
Wheelersburg, private road crossing east and west, just south of (1 mile to water board), 1 mile north of	38 44 31.6	82 52 09.8
Railroad bridge over Little Scioto River, private road crossing just south of	38 45 13.4	82 52 52.7

TRUMBULL COUNTY.

KINSMAN QUADRANGLE.

The following geographic positions were obtained by Mr. J. R. Ellis, topographic aid, in 1904. The line starts at a point located by primary traverse near southwest corner of quadrangle, follows highways along the western border of the quadrangle, and is tied to a position near Triumph, located by Mr. C. B. Kendall in 1903.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Schoolhouse, T road east; 21 feet southeast to W. B. King's mail box, 21 feet northwest to west end of stone culvert	° ′ ″ 41 15 40.2	° ′ ″ 80 44 26.9
Guidepost ("Cortland 4 mi."), road northeast at, 90 feet north to guidepost	41 16 31.6	80 44 27.1
T road east, 35 feet northeast to corner fence post, 34 feet southeast to corner fence post	41 17 02.8	80 44 27.4
T. 5 N., R. 3 W., corner to secs. 47, 48, 53, and 54, T road south at, 13 feet north to A. Barnard's mail box, 40 feet southeast to C. W. Kennedy's mail box	41 18 29.7	80 44 28.2

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
T. 5 N., R. 3 W., corner to secs. 14, 15, 27, and 28, crossroads; 37 feet southwest to corner fence post, 42 feet northwest to guidepost	° ′ ″ 41 19 48.6	° ′ ″ 80 44 28.5
Cortland, guidepost at Y road north, 2 miles north of	41 21 11.1	80 44 13.5
Mecca, 1 mile south of; in west part of yard to schoolhouse, nail in east face of maple tree bears S. 55° W., distant 73.5 feet; nail in south face of maple tree near fence bears N. 19° E., distant 79.8 feet; iron post stamped "Prim. Trav. Sta. No. 34"	41 21 53.2	80 44 12.4
Mecca, corner stone in center of park	41 23 22.7	80 44 13.3
Crossroads, 40 feet northwest to guidepost, 40 feet southwest to cross on fence post	41 25 07.9	80 44 13.7
T. 7 N., R. 3 W., corner secs. 44, 45, 46, and 47, T road east; 10 feet northeast to milk platform	41 25 58.1	80 44 13.8
Crossroads, center of bridge	41 26 51.4	80 44 47.7
Kenilworth, crossroads 0.5 mile west of; 40 feet northeast to telephone pole, 66 feet southeast to maple tree	41 27 43.4	80 44 48.2
Triumph, T road east 1 mile south of; 27 feet west to wild cherry tree, 70 feet southeast to maple tree	41 28 36.7	80 44 48.5
Triumph, crossroads, 57 feet southwest to northeast corner of shop, 40 feet southeast to C. M. Rice's mail box	41 29 28.4	80 44 48.6
Triumph, 0.75 mile north of; in southeast corner of Mrs. E. P. Priar's farm, on west side of Jefferson road, northeast corner of W. Cleat's residence bears S. 37° 20′ W., distant 48.6 feet; southwest corner of O. B. Humphrey's house bears N. 29° E., distant 129.4 feet; in stone post, aluminum tablet stamped "Prim. Trav. Sta. No. 35"	41 30 08.1	80 45 03.0
Schoolhouse, nail in plug at three corners	41 30 51.9	80 45 17.6

COLUMBIANA AND MAHONING COUNTIES.

LEETONIA QUADRANGLE.

The following geographic positions were obtained from primary traverse run in 1904 by Mr. J. R. Ellis. The line starts from an adjusted position at Canfield and runs south over the Erie Railroad to Leetonia; continues southward along highways to Lisbon; thence westward over highways along south border of quadrangle, and is tied to Kensington triangulation station United States Geological Survey.

Geographic positions along the Erie Railroad between Canfield and Washingtonville.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Canfield, west end of water trough at crossroads	41 01 29.36	80 45 38.59
Canfield, in town park, cross on southwest corner to water trough bears N. 2° 50′ E., distant 32.15 feet; cross on northeast corner of foundation of Farmers National Bank bears N. 47° W., distant 148.4 feet; iron post stamped "Prim. Trav. Sta. No. 143"	41 01 26.1	80 45 38.6
Canfield, T road east 1 mile south of; 19 feet northeast to end of culvert, 58 feet southeast to cross on telephone pole	41 00 19.9	80 45 38.7
T road south, 90 feet west to east and west road crossing, Erie Railroad	40 59 17.8	80 45 49.2
Corner to secs. 1, 2, 11, and 12, at crossroads	40 58 21.5	80 45 49.5
Corner secs. 11, 12, 13, and 14, at crossroads, 21 feet southeast to mail box, 18 feet southwest to west end of culvert.	40 57 29.8	80 45 50.3
Crossroads at schoolhouse, corner secs. 13, 14, 23, and 24.	40 56 38.0	80 45 50.8
Corner secs. 23, 24, 25, and 26	40 55 46.1	80 45 51.4
Schoolhouse, T road west at, 14 feet north to east end of stone culvert, 21 feet northwest to west end of culvert	40 55 01.3	80 45 52.0
Washingtonville, Main street crossing of Erie Railroad	40 54 02.6	80 45 50.5

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Leetonia, 0.5 mile northwest of; in southwest corner of city reservoir grounds, cross cut on stone foundation of left side of ventilator bears N. 52° 10′ E., distant 50.3 feet; cross cut on northeast corner of foundation to Mont Stover's residence bears S. 89° W., distant 106.4 feet; iron post stamped "Prim. Trav. Sta. No. 44".	40 53 14.4	80 45 52.8
Leetonia, north and south road crossing Pennsylvania Railroad at Salem Iron Works	40 52 22.7	80 45 53.6
Leetonia, crossroads 2.5 miles south of; 24 feet southwest to guidepost, 39 feet southeast to mail box	40 51 03.0	80 45 54.3
T. 15, R. 3, corner to secs. 23, 24, 25, and 26	40 50 33.7	80 45 54.5
Crossroads at schoolhouse, T. 15, R. 3, corner to secs. 25, 26, 35, and 36	40 49 40.8	80 45 54.9

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Ts. 14 and 15, R. 3, corner secs. 1, 2, 35, and 36, at T road north	40 48 48.7	80 45 55.0
Lisbon, T road west, 0.25 mile east of; covered bridge, 21 feet northwest to corner fence post, 31 feet southeast to mail box	40 47 56.2	80 45 38.8
Lisbon, crossroads 0.25 mile northeast of, 30 feet northwest to cross on telephone pole, 42 feet southeast to water trough	40 46 51.9	80 45 47.4
Lisbon, in southwest corner of eastmost park; east corner of foundation to mounted gun bears N. 79° 15′ W., distant 78.8 feet; bronze tablet in northeast corner of court-house bears S. 48° 05′ W., distant 119.9 feet; iron post stamped "Prim. Trav. Sta. No. 45"	40 46 20.3	80 46 04.6
T. 14, R. 3, corner secs. 15, 16, 21, and 22	40 46 12.3	80 48 13.6
Lisbon, T road south, 2.5 miles west of; 39 feet southwest to P. Joseph's mail box, 36 feet east to large white-oak tree	40 46 07.0	80 48 59.7
T. 14, R. 3, corner to secs. 17, 18, 19, and 20, at crossroads; 18 feet northeast to mail box, 36 feet southeast to 4 milepost	40 46 12.5	80 50 30.0
Lisbon, 5.5 miles west of; in southwest corner of Charles Miller's stable lot; cross on southwest corner to foundation to residence bears N. 56° 20′ E., distant 111 feet; cross on southwest corner of stable foundation bears S. 66° E., distant 106 feet; cemented in sandstone post; aluminum tablet stamped "Prim. Trav. Sta. No. 47"	40 45 55.9	80 51 56.8
Hanoverton, T road 3 miles northeast of; 46 feet northeast to guidepost, 10 feet south to cross on fence post	40 45 58.4	80 52 42.6
Hanoverton, crossroads 2.5 miles east of; 18 feet south to mail box, 24 feet northwest to mail box	40 45 47.1	80 53 36.7
Hanoverton, T road north, 1.25 miles east of; 53 feet northeast to telephone pole, 36 feet northwest to cross on rail fence	40 45 21.0	80 54 11.6
Hanoverton, crossing of Canal and First streets at 60 feet northeast to southwest corner of Wilhelm Hotel, 241 feet northwest to lamp post	40 45 03.7	80 56 12.7
Kensington triangulation station, 1 mile south of Kensington, on highest point of wooded hill; a county road passes over south side; station mark: A marble post 48 by 6 by 6 inches, 36 inches in ground, in center of top of which is cemented a bronze triangulation tablet stamped "U. S. Geological Survey, Ohio"	40 43 20.6	80 56 39.1

This line starts from Kensington triangulation station of the United States Geological Survey and runs northward over highways through Beloit to a point 1.75 miles west of Berlin Center.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Milepost 50, road crossing 620 feet west of	40 44 05.4	80 58 52.3
Lynchburg, road crossing 0.25 mile south of	40 44 19.4	81 00 02.4
Thomas (J. C.), field of, in northwest corner of, east side of north and south road and just south of road to east; cross on northeast corner of foundation to Thomas's residence, N. 66° W., distant 54.5 feet; nail in west face of locust tree on east and west fence line bears N. 87° 10′ E., distant 117.6 feet; in top of sandstone post; aluminum tablet stamped "Prim. Trav. Sta. No. 48"	40 45 38.3	80 59 58.3
Road west, 18 feet north to guidepost, 24 feet south to corner stone	40 46 14.6	80 59 43.3
Section corner, T road east, 15 feet northwest to fence post, 27 feet northeast to guidepost	40 47 06.6	80 59 38.8
Section corner, no numbers, T road east at schoolhouse	40 47 59.0	80 59 38.4
New Alexander, crossroads 2 miles north of; 39 feet southwest to guidepost, 9 feet east to stone in center of east and west road	40 48 50.1	80 59 32.0
North Georgetown, crossroads 1 mile south of; 28 feet northeast to east end stone culvert, 30 feet northwest to cross on telephone pole	40 49 42.6	80 59 20.7
North Georgetown, crossroads, 30 feet southwest to guidepost, 32 feet northwest to American Hotel signpost	40 50 35.2	80 59 10.1
Section corner stone to sections 14 and 23, T. 6, R. 5, T road west at	40 51 28.0	80 59 39.0
Section corner stone, crossroads at	40 52 20.4	80 59 39.1
T road east, 33 feet southeast to northwest corner of schoolhouse, 19 feet northeast to north end of culvert	40 53 13.2	80 59 39.0
Westville, on property owned by R. F. Randolf; northwest corner to Randolf stable bears S. 25° E., distant 15.2 feet; northwest corner to tile foundation to blacksmith shop bears N. 59° 40′ W., distant 65 feet; iron post stamped "Prim. Trav. Sta. No. 49"	40 54 08.0	80 59 38.8
Beloit, Pennsylvania Railroad at north and south road crossing	40 55 14.7	80 59 37.6
Section corner 23 and 24, T road west	40 55 50.0	80 59 37.4
Crossroads, 31 feet northeast to cross on telephone pole, 22 feet northwest to cross on milk platform	40 56 42.1	80 59 37.2
Snodes station, corner to secs. 11, 12, 13, and 14, road crossing of Pennsylvania Railroad	40 57 34.3	80 59 37.0
Corner to secs. 1, 2, 11, and 12	40 58 26.5	80 59 36.9
Corner to secs. 1 and 2, at T road S	40 59 16.2	80 59 36.8
Christie's pottery, crossroads at; 42 feet southwest to letter box, 39 feet southeast to cross on telephone pole	40 59 59.4	80 59 08.9

ROSS COUNTY.

NEW HOLLAND AND ROXABELL QUADRANGLES.

The following geographic positions were determined from primary traverse run in 1904 by J. R. Ellis. The line starts from adjusted position at southeast corner of Washington Court House quadrangle and follows public highways east to northwest corner of Chillicothe quadrangle.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Schoolhouse No. 9, in northeast corner of yard, northeast corner of schoolhouse bears S. 53° 45′ W., distant 30.4 feet; center of wood pump in schoolhouse yard bears N. 71° 15′ W., distant 51.2 feet; in top of sandstone post 5 by 10 by 30 inches, aluminum tablet stamped "Prim. Trav. Sta. No. 5"	° ′ ″ 39 30 15.0	° ′ ″ 83 15 03.5
Schoolhouse No. 9, center of bridge about 1 mile east of	39 30 19.1	83 13 49.3
Schoolhouse No. 1, Deerfield Township, T road west, 33 feet northwest to cross on board fence, 26 feet southwest to cross on east end of wood steps	39 30 23.4	83 12 30.7
Egypt Church, intersection of roads about 300 feet north of; 27 feet north to cross on corner fence post; 48 feet west to front yard gate	39 29 59.0	83 12 10.1
Clarksburg, T road north 1.5 miles west of; 30 feet northeast to cross on corner of fence; 33 feet northwest to cross on large corner fence post	39 30 11.4	83 10 46.1
Clarksburg, T road northwest 0.75 mile southwest of; 27 feet east to cross on gatepost; 25 feet southeast to cross on telephone pole	39 30 05.6	83 09 50.1
Clarksburg, in north corner of James Corcoran's property; southeast corner of foundation of Wilkins's residence bears N. 60° 30′ W., distant 43 feet; northwest corner to brick foundation to James Corcoran's front porch bears S. 30° E., distant 96.3 feet; iron benchmark post stamped "Prim. Trav. Sta. No. 6"	39 30 16.2	83 09 11.7
Clarksburg, T road southwest 1 mile southeast of; 18 feet west to cross on white-oak tree; 28 feet north to A. L. Lippincott's mail box	39 29 41.5	83 08 20.6
Bridge, T road northeast about 400 feet southeast of (on Chillicothe pike); 33 feet north to cross on telephone pole, 40 feet east to cross on corner fence post	39 29 11.5	83 07 37.1
Carrie, T road north; 19 feet northwest to north corner of post-office porch; 50 feet east to cross cut on board fence	39 29 36.5	83 06 10.8
Deer creek, south end of steel-covered bridge over	39 29 12.1	83 05 06.3
T road northeast, 21 feet west to mail box; 30 feet north to cross on corner fence post	39 29 21.1	83 04 32.3
Schoolhouse No. 3, T road north; 27 feet southeast to cross on gatepost; 30 feet northwest to cross on corner fence post	39 28 55.0	83 03 13.8
Yellowbud, T road west 0.75 mile south of; 25 feet northeast to cross on telephone pole; 40 feet southwest to cross on corner fence post	39 29 28.7	83 00 48.9
Yellowbead, *town pump at T road east*	39 30 11.8	83 00 35.0

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Yellowbud, in southeast corner of George Kline's front yard on east side of canal; southeast corner of foundation to Kline's residence bears N. 43° 50′ W., distant 25.9 feet; center of southeast corner fence post of yard bears S. 60° E., distant 3.4 feet; lower hinge of front yard gate bears S. 77° 20′ W., distant 37.4 feet; in 7 by 14 by 26 inch sandstone post, aluminum tablet stamped "Prim. Trav. Sta. No. 7"	° ′ ″ 39 30 12.0	° ′ ″ 83 00 29.8
Yellowbud, T road east about 1.75 miles south of; 21 feet southwest to cross on telephone pole, 21 feet northeast to cross on fence post	39 28 39.3	83 01 02.5

PORTAGE COUNTY.

RAVENNA QUADRANGLE.

The following geographic positions were obtained by Mr. J. R. Ellis, topographic aid, in 1904, by primary traverse line along the Lake Erie, Alliance and Western Railroad from Phalanx to Deerfield; thence along highways to Atwater, where it was tied to a traverse position located in 1900:

Geographic positions along highways.

Station.	Latitude.	Longitude.
Christie's pottery, crossroads 1 mile north of; 35 feet north to cross on board fence, 39 feet north to corner fence post	° ′ ″ 41 00 37.1	° ′ ″ 80 59 10.7
Berlin Center, crossroads, 1.75 miles west of; at schoolhouse	41 01 28.1	80 59 11.4
T road south at stone culvert	41 01 28.8	81 00 08.2
Deerfield, station, in southeast corner of Hubbards orchard on north side of road east and west, 418 feet east of road crossing, northeast corner of house owned by Mullen Coal Co. bears S. 51° 15′ E., distant 160.1 feet; nail in root of black oak tree on south side road bears S. 42° 15′ W., distant 72 feet; iron post stamped "Prim. Trav. Sta. No. 38"	41 01 29.3	81 01 11.8
T road south, 27 feet southeast to telephone pole	41 01 28.8	81 02 34.7
T. 1, R. 6, corner to secs. 29, 30, 31, and 32	41 01 28.5	81 03 02.1
T road south, 36 feet southeast to cross on corner fence post, 13 feet north to A. H. Legaller's mail box	41 01 28.9	81 03 54.4
Deerfield, 0.5 mile west of; T. 1, R. 6, corner to secs. 43, 44, 52, 53	41 01 29.0	81 04 46.1
T. 1, R. 6, corner secs. 55 and 56, crossroads, 36 feet southwest to guidepost, 40 feet southeast to large fence post	41 01 29.0	81 05 55.6
Crossroads, 40 feet northeast to cross on corner yard fence, 40 feet southeast to cross on corner board fence	41 01 24.6	81 07 25.0
Atwater, crossroads	41 01 25.2	81 08 53.3
Atwater, in northeast corner of George Heiser's front lawn, iron post stamped "Prim. Trav. Sta. No. 37"	41 01 25.1	81 09 41.5
Atwater, Pennsylvania Railroad at east and west road crossing	41 01 25.4	81 09 49.4

Geographic positions along the Lake Erie, Alliance and Wheeling Railroad between Newton Falls and Deerfield.

Station.	Latitude.	Longitude.
Newton Falls, 2.66 miles south of; in southwest corner of D. T. Hott's farm, at east and west road crossing, nail in root of gum tree bears N. 53° 40′ E., distant 72.4 feet; nail in root of black-oak tree bears S. 79° 55′ E., distant 39.8 feet, in sandstone post, aluminum tablet stamped "Prim. Trav. Sta. No. 36"	° ′ ″ 41 09 10.8	° ′ ″ 81 00 05.3
Pritchard, road crossing	41 08 03.1	81 00 29.2
Road crossing	41 06 48.2	81 00 51.6
Diamond post-office, road crossing at station	41 05 55.5	81 01 21.3
Diamond post-office, road crossing 1 mile south of	41 05 14.0	81 01 21.3
Davis, road crossing at station	41 04 22.3	81 01 20.7
Davis, road crossing east and west 0.75 mile south of station	41 03 43.8	81 01 16.9
Schoolhouse, road crossing	41 02 47.6	81 01 16.7
Deerfield station, road crossing east and west 70 feet northwest of	41 01 29.0	81 01 17.2

JACKSON, PIKE, AND SCIOTO COUNTIES.

SCIOTO QUADRANGLE.

The line starts from adjusted position at Glade and runs south along highways to southeast corner of quadrangle; thence along Baltimore and Ohio Southwestern Railroad to Sciotoville; thence along Norfolk and Western Railroad to Portsmouth, and north to Sargents. A line was also run from Portsmouth along highway to Scioto triangulation station, United States Coast and Geodetic Survey:

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Glade, north and south road crossing	39 00 48.9	82 46 58.4
Glade, in John Whitman's woods pasture; 440 feet south of road crossing; on east side of north and south road, spike in north face of white-oak tree bears S. 14° 10′ E., distant 27.3 feet; spike in white-oak tree bears S. 46° E., distant 31.6 feet; iron bench-mark post set 40 inches in the ground, stamped "Prim. Trav. Sta. No. 20"	39 00 44.6	82 46 58.5
Glade, T road west 1 mile south of; 15 feet east to cross on fence, 30 feet northwest to cross on corner fence post	39 00 04.0	82 47 02.3
Schoolhouse, T road west just south of; 15 feet east to cross on rail fence, 36 feet southwest to cross on corner fence post	38 59 21.2	82 46 40.9
Crabtree's (Mary), residence, crossroads at; 21 feet northwest to cross on picket fence, 35 feet southeast to cross or corner post to yard fence	38 58 41.6	82 46 27.0

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
T road east, 30 feet southeast to cross on fence post; 21 feet northeast to cross on white-oak tree	° ′ ″ 38 57 27.2	° ′ ″ 82 46 15.5
T. 5, R. 19, corner to secs. 5 and 6	38 56 46.6	82 46 08.4
Myrtle post-office (discontinued), 0.25 mile north of; in ground in northwest part of Hamilton churchyard; wire nail in cross cut on south face of large white-oak tree on north side of east and west road bears N. 27° E., distant 49.5 feet; cross cut on northwest corner of foundation to church bears S. 15° 45′ E., distant 13.1 feet, iron bench-mark post stamped "Prim. Trav. Sta. No. 21"	39 55 18.8	82 45 34.8
T. 5, R. 19, quarter corner between secs. 8 and 17	39 54 54.5	82 45 52.5
McDaniel's residence, intersection of roads south of; 30 feet north to cross on sycamore tree; 24 feet south to arrow on corner fence post	39 54 38.9	82 46 42.8
Schoolhouse No. 12, near; cemented in solid rock, bench-mark tablet stamped elevation "678 feet"	38 54 16.1	82 46 42.7
Dever's (J. H.) farm, T road west just north of covered bridge; 27 feet southwest to cross on top board fence, 24 feet east to J. H. Dever's mail box	39 53 43.5	82 46 18.6
Iron bridge over Brushy Fork, T road west; 60 feet west to east end of bridge; 60 feet north to J. D. Martin's mail box	39 53 10.8	82 46 30.0
T. 5, R. 20, 0.25 mile west of corner to secs. 28, 30, 32, and 33	38 52 12.1	82 45 59.6
Intersection of roads near church; east end of small bridge	38 51 24.0	82 46 06.7
Pinkerman, in Liberal Brethren Church, southwest corner of foundation to church bears N. 67° E., distant 6.3 feet; northwest corner foundation to church bears N. 45° E., distant 38 feet; iron post set 36 inches in the ground stamped "Prim. Trav. Sta. No. 22"	39 50 17.4	82 46 09.9

Geographic positions along the Baltimore and Ohio Southwestern Railroad between Webster and Scioto Furnace.

Station.	Latitude.	Longitude.
Webster, road crossing Baltimore and Ohio Southwestern Railroad about 0.75 mile southwest of	° ′ ″ 39 48 57.4	° ′ ″ 82 44 27.0
Trestle No. 374, north and south road crossing under	38 48 28.8	82 45 35.5
Scioto Furnace station	38 47 57.9	82 45 54.8

Geographic positions along highways.

Station.	Latitude.	Longitude.
Cameron farm, crossroads; 33 feet southeast to cross on apple tree	° ′ ″ 39 46 49.1	° ′ ″ 82 45 17.7
Scioto Furnace, 3 miles south of; in orchard at John Bisco's farm; southwest corner of stone foundation bears N. 40° 35′ E., distant 108.6 feet; wire nail in south face of apple tree used for gatepost bears N. 30° 45′ E., distant 22.5 feet; iron bench-mark post stamped "Prim. Trav. Sta. No. 23"	39 45 48.3	82 46 24.4
Corner to secs. 4, 5, 8, and 9, T road west; 24 feet northwest to E. Strickland's mail box; 24 feet southeast to cross on fence post	39 45 22.7	82 46 38.0

Geographic positions along the Baltimore and Ohio Southwestern Railroad between Sciotoville and Lilly.

Station.	Latitude.	Longitude.
Sciotoville, in east corner of W. M. Price's property; on north side of Baltimore and Ohio Southwestern Railroad just off of right of way; northeast corner of foundation to Sciotoville Milling Company's building bears S. 6° 50′ E., distant 168.5 feet; northeast corner of Baltimore and Ohio Southwestern Railroad depot bears S. 59° W., distant 441.5 feet; iron bench-mark post set 42 inches in the ground stamped "Prim. Trav. Sta. No. 26."	° ′ ″ 39 45 37.9	° ′ ″ 82 53 26.9
Milepost 48, road crossing north and south 600 feet west of	39 46 05.0	82 52 14.2
Slocum, road crossing north and south west of platform	39 45 59.8	82 50 32.9
Slocum, road crossing east and west 1 mile east of	39 45 58.1	82 49 39.6
Milepost 45, road crossing 220 feet south of	39 46 29.8	82 49 16.7
Trestle No. 387, road crossing under	39 46 36.3	82 48 27.7
Lilly, road crossing at south end of switch	39 47 06.5	82 47 46.5
Lilly, overhead road crossing 0.75 mile northeast of	39 47 31.8	82 47 09.7

Geographic positions along the Norfolk and Western Railroad between Doty, Portsmouth, and Sargents.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Doty station	39 45 19.5	82 54 23.9
New Boston, road crossing just west of Burgess steel plant (south track)	39 44 50.7	82 56 08.6
Norfolk and Western shops, road crossing north and south (south track)	39 44 28.6	82 57 25.5
Portsmouth, Gallia street crossing (south track)	39 44 15.4	82 58 35.4
Portsmouth, northeast corner of Tracy Park; northwest corner of brick foundation to residence on southeast corner of Tenth and Findlay streets bears S. 80° 15′ E., distant 101.1 feet; northeast corner to foundation of Tracy monument bears S. 63° 30′ W., distant 261.9 feet; iron bench mark post stamped "Prim. Trav. Sta. No. 27."	39 44 17.1	82 59 40.3
Chillicothe and Portsmouth pike crossing	39 44 44.5	82 59 32.6
Junction, road crossing under trestle No. 1068; 700 feet north of (east track)	39 45 43.7	82 59 28.2
Milepost 97, private road crossing 870 feet north of (west track)	39 46 53.7	82 59 07.7
Milepost 96 (east track)	39 47 33.0	82 59 09.4
Chillicothe and Portsmouth pike crossing under trestle No. 1081 (west track)	39 48 38.7	82 59 05.6
Davis station	39 49 34.2	82 58 57.3
Davis station, road crossing under trestle No. 1083, 1 mile north of	39 50 28.0	82 59 03.0
Schoolhouse, private road crossing	39 51 07.1	82 59 12.0
Milepost 90, private road crossing 200 feet south of	39 52 13.2	82 59 38.3
Lucasville, at southwest corner of Purdue Brothers' roller mills, southeast corner of foundation to elevator bears N. 58° 20′ W., distant 53.5 feet; cross on southwest corner of foundation to roller mills bears N. 1.4 feet distant; iron bench mark post set 42 inches in the ground, stamped "Prim. Trav. Sta. No. 28."	39 52 51.6	82 59 44.4
Milepost 88, private road crossing 1,080 feet south of	39 53 45.3	83 00 05.1
Milepost 87, Chillicothe and Portsmouth pike crossing northwest and southeast 630 feet north of	39 54 48.0	83 00 44.4
Clifford station	39 55 29.3	83 01 12.4
Wakefield, road crossing east and west 1 mile south of	39 57 14.3	83 01 22.6
Wakefield, road crossing	39 58 13.1	83 01 14.2
Wakefield, Chillicothe and Portsmouth pike crossing 1 mile north of	39 58 57.7	83 01 19.5
Sargents Pit, private road crossing 760 feet south of milepost 81 near	39 59 38.0	83 01 21.0

Geographic positions along highway between Portsmouth and Scioto triangulation station, United States Coast and Geodetic Survey.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Portsmouth, south end of wagon bridge over Scioto River	38 43 53.5	83 00 40.4
Bertha, T road northwest just south of; 12 feet north to cross on post; 20 feet east to cross on telephone pole	39 44 51.5	83 01 50.0
Scioto triangulation station (United States Coast and Geodetic Survey); on land of George Davis, 1.5 miles west of his distillery at west side of Scioto River, which is about 1.5 miles northwest of Portsmouth. Station mark: Center is marked by a pottery pyramid sunk 3 feet below surface, over which was placed a 6-inch drain tile pipe 2 feet long filled with concrete, in center of which is an iron spike. Four 4-inch pipes, each filled with concrete, with a nail marking their centers, are, one north, 6.29 feet; one south, 6.18 feet; one east, 6.25 feet; and one west, 6.11 feet	38 45 47.7	83 03 03.6

MAHONING AND TRUMBULL COUNTIES.

WARREN QUADRANGLE.

The following geographic positions were obtained from primary traverse run in 1904 by Mr. J. R. Ellis. The line starts from an adjusted position at Phalanx station, runs southward over the Lake Erie, Alliance and Wheeling Railroad through Diamond, and connects with adjusted position at Deerfield. A line was also run from an adjusted position near Berlin Center east over highways along south border of quadrangle to Canfield; thence north over highways to Ohlstown; thence north over Erie Railroad, and was tied to an adjusted position 5 miles east of Warren.

Geographic positions along the Lake Erie, Alliance and Wheeling Railroad.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Phalanx station, bench mark No. 32	41 14 55.7	80 57 17.3
Briceville, crossing of the Lake Erie, Alliance and Wheeling Railroad and the Erie Railroad	41 13 45.6	80 57 31.1
Road crossing east and west	41 13 16.3	80 57 43.6
Private road crossing east and west	41 11 55.6	80 58 03.2
Newton Falls, road crossing 320 feet north of station	41 11 16.5	80 58 21.7
Newton Falls, road crossing north and south 1 mile south of	41 10 34.5	80 59 01.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Schoolhouse, crossroads; 31 feet southwest to guidepost; 27 feet southeast to A. L. Bardos's mail box	41 01 28.1	80 59 11.4
Berlin Center, crossroads, 24 feet southeast to pump, 90 feet northeast to corner of stone porch	41 01 28.6	80 56 52.2
Berlin Center, Pennsylvania Railroad, east and west road crossing 1 mile east of	41 01 28.5	80 55 33.7
Berlin Center, 2 miles east of; in southwest corner of H. C. Beardsley's farm at crossroads, nail in root of hickory tree bears north 57° 30′ E., distant 24.3 feet; nail in root of hickory tree bears N. 26° 30′ W., distant 8.5 feet; iron post stamped "Prim. Trav. Sta. No. 39"	41 01 27.3	80 54 20.8
Ellsworth Center, crossroads; 40 feet southwest to guidepost, 100 feet northeast to iron pump	41 01 28.0	80 51 27.0
Meander Creek, center of bridge over	41 01 29.8	80 50 18.2
T road south, 42 feet northwest to Peach Hill Coal Co.'s mail box, 32 feet north to cross on picket fence	41 01 28.7	80 48 34.1
Canfield, crossroads 1.5 miles west of; 40 feet southwest to guidepost, 36 feet southeast to mail box	41 01 29.3	80 47 16.2
Canfield, west end of stone water trough at crossroads	41 01 29.4	80 45 38.6
Canfield, crossroads 1 mile north of; 43 feet southwest to guidepost, 36 feet northeast to telephone pole	41 02 39.2	80 45 38.4
Canfield, T road west 2 miles north of; 36 feet southwest to corner hedge fence, 45 feet northwest to hickory post	41 03 20.4	80 45 38.3
Sample, crossroads; 17 feet southeast to guidepost, 52 feet northeast to churchyard gate	41 04 08.4	80 45 42.0
Austintown, crossroads 1 mile south of; 33 feet southeast to corner of yard fence, 35 feet southwest to telephone pole	41 05 02.6	80 45 46.0
Austintown, iron pump at crossroads	41 05 58.6	80 45 50.0
National Sandstone plant, road crossing tramway to	41 06 50.2	80 46 26.1
Ohlstown, road crossing Erie Railroad	41 07 18.8	80 46 47.8
Mineral Ridge, in southeast corner of E. R. Edwards's farm on west side of road; northeast corner of Andrew Armalio's residence, bears S. 58° W., distant 20.1 feet, southwest corner of Erie Railroad depot, bears N. 2° E. distant 355 feet, iron post stamped "Prim. Trav. Sta. No. 40"	41 08 19.3	80 46 26.0
Road crossing east and west	41 08 59.3	80 46 35.6
Niles and Mineral Ridge pike crossing	41 09 38.3	80 46 07.5
Niles, crossing of Erie Railroad (branch) and Baltimore and Ohio Southwestern Railroad	41 10 34.0	80 45 20.3
Niles, Cedar street and Vienna avenue, 21 feet west to stone hitching post, 45 feet northeast to telephone pole	41 11 22.6	80 45 11.9
Crossroads	41 12 19.4	80 44 25.2
T road east, 25 feet northwest to Hayrick's mail box, 27 feet southwest to front yard gate	41 13 26.2	80 44 25.4

This line starts at an adjusted position at Phalanx and runs east over Erie Railroad and highways along south border of quadrangle to a point 4 miles east of Warren.

Geographic positions along Erie Railroad between Phalanx and Warren.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Phalanx station, road crossing of Erie Railroad 1 mile west of	41 15 12.8	80 58 39.8
Phalanx station, in southeast corner of G. W. Strong's yard; southeast corner of foundation of Strong's house bears N. 24° 20′ W., distant 95.5 feet; north rail of north track of Erie Railroad at road crossing bears S. 6° 40′ E., distant 157.5 feet; iron post stamped "Prim. Trav. Sta. No."	41 14 55.7	80 57 17.3
Phalanx station, road crossing 1 mile east of	41 14 37.1	80 56 04.4
Milepost 48, road crossing 400 feet east of	41 14 22.8	80 55 03.5
Milepost 49, road crossing 1,200 feet west of	41 14 17.9	80 54 18.5
Leavittsburg, road crossing just west of station	41 14 15.7	80 52 50.3
Milepost 51, road crossing 500 feet east of	41 14 09.7	80 51 38.3
Warren Tile Co., road crossing north and south	41 14 01.5	80 50 09.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Warren, copper bolt in south meridian stone in courthouse yard	41 14 11.6	80 49 06.8
Warren, Market street crossing Pittsburgh, Painesville and Fairport Railroad	41 14 10.8	80 48 13.0
Mosquito Creek, crossroads 0.5 mile west of; 30 feet north to mail box, 36 feet southeast to mail box	41 14 13.8	80 45 58.0
Crossroads, in southwest corner of Z. T. Ewalt's garden on north side of road just west of; northwest corner foundation of Ewalt's new house bears N. 43° 30′ W., distant 83.6 feet; southwest corner of foundation to porch of Ewalt's old house bears S. 89° 10′ E., distant 208.6 feet; iron post stamped "Prim. Trav. Sta. No. 33"	41 14 18.0	80 44 27.9

JACKSON, PIKE, AND ROSS COUNTIES.

WAVERLY QUADRANGLE.

The line starts from primary traverse station No. 15 (near northwest corner of quadrangle) and follows the Chillicothe and Portsmouth pike south to Waverly; thence south along Norfolk and Western Railroad to Sargents; thence east along highways to Glade; thence north along highway to tie point at Gillespieville.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Waller, forks of road about 2 miles south of; 45 feet west to G. W. Bender's mail box; 40 feet northeast to cross on telephone pole	° ′ ″ 39 14 53.4	° ′ ″ 82 58 50.9
Milepost, "Waverly, 8 miles," center of Chillicothe and Portsmouth pike	39 14 06.7	82 59 03.7
T road west, 15 feet east to cross on gatepost, 27 feet southwest to cross on white oak tree	39 13 20.0	82 59 01.9
Hermit Cave, road east near, 15 feet northwest to southwest corner of bridge, 30 feet southeast to mail box	39 11 53.9	82 58 43.7
Coler's store, T road northeast, 30 feet east to pump, 27 feet to arrow on telephone pole	39 11 02.8	82 58 34.2
Alma, T road west about 1 mile south of; 36 feet southeast to cross on telephone pole	39 10 31.5	82 58 30.6
Waverly, dirt road northeast, 2 miles north of; 15 feet east to cross on board fence, 21 feet northwest to cross on telephone pole	39 09 05.9	82 58 37.8
Waverly, T road west 0.75 mile north of; 15 feet east to cross on telephone pole; 18 feet northwest to northeast corner of bridge	39 08 18.0	82 58 55.9
Waverly, in west corner of court-house yard, west corner of foundation to court-house bears S. 62° 50′ E., distant 31.7 feet; corner iron fence post to court-house yard bears W. 2.9 feet, iron bench mark post set 36 inches in ground stamped "Prim. Trav. Sta. No. 16"	39 07 33.8	82 59 04.0

Geographic positions along the Norfolk and Western Railroad between Glen Junction and Sargent station.

Station.	Latitude.	Longitude.
Glen Junction, crossing of Norfolk and Western and Detroit Southern railroads	° ′ ″ 39 06 48.4	° ′ ″ 82 58 41.5
Chillicothe and Portsmouth pike crossing	39 05 53.6	82 58 21.0
Milepost 634, 600 feet north of; private road crossing	39 05 09.3	82 59 03.0
Glen Junction, private road crossing 2.75 miles south of	39 04 34.3	82 59 39.7
Piketown station, road crossing 165 feet north of	39 03 51.0	83 00 50.3
Piketown, crossing Chillicothe and Portsmouth pikes 1 mile south of	39 03 14.6	82 01 09.9
Switch block to spur	39 02 34.9	82 01 35.3
Sargents, road crossing east and west 1 mile north of	39 01 20.9	82 01 32.7
Sargents station, 1,200 feet north of; in southwest corner of Mrs. Carrie Sargent's farm; on east side of Chillicothe and Portsmouth pike; wire nail in cross cut in west face of sugar maple tree bears S. 88° 05′ E.; 9 feet southwest to corner post to southwest corner of Mrs. Sargent's farm; iron bench-mark post stamped "Prim. Trav. Sta. No. 17"	39 00 39.1	82 01 24.8

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Shyville, forks of road 0.25 mile southeast of; 24 inches southwest to cross on corner fence post, 18 inches west to south end of culvert	39 00 27.7	82 59 07.8
Church, intersection of roads north of; 27 feet northwest to cross on hickory tree, 27 feet east to cross on small black oak	39 00 50.1	82 57 05.9
Bobs, road west about 0.5 mile northeast of; 21 feet west to cross on large white oak tree, 22 feet east to cross on corner fence post	39 01 40.6	82 56 07.7
Beaver, intersection of roads 5 miles west of; 18 feet southeast to guide post, 18 feet southwest to cross on small oak tree	39 02 05.0	82 55 17.8
Beaver, crossroads, at Arminstrout schoolhouse, 4 miles west of; 21 feet southeast to corner fence post, 30 feet southwest to cross on board fence	39 02 00.2	82 54 05.3
Beaver, 2.5 miles west of; church at crossroads, in northeast corner of churchyard; cross cut on northeast corner of foundation to church bears S. 56° 15′ W., distant 27.3 feet; 2 nails in blaze on west face of locust tree in northeast corner of churchyard bears S. 82° 30′ E., distant 6.5 feet; iron bench-mark post set 42 inches in the ground, stamped "Prim. Trav. Sta. No. 18"	39 01 56.7	82 52 43.8

Geographic positions along the Detroit Southern Railway between Beaver and Glade.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Beaver, Beaver and Waverly pike crossing Detroit Southern Railroad, 1.5 miles west of	39 01 53.9	82 51 30.2
Beaver, road crossing north and south, 1 mile west of	39 01 40.6	82 50 47.6
Beaver station, road crossing north and south, 35 feet east of	39 01 25.2	82 49 39.2
Beaver, road crossing north and south at east end of siding	39 01 18.3	82 49 08.6
Glade, private road crossing 0.75 mile west of	39 00 59.2	82 47 44.1
Glade, north and south road crossing	39 00 48.9	82 46 58.4

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Salem Church, intersection of roads at bridge, 0.25 mile north of; 35 feet west to northeast corner of bridge	39 01 34.4	82 47 12.9
Hoover's (H. B.) residence, road east through gate at bridge; 18 feet southeast to cross on butternut tree, 16 feet northeast to cross on locust tree	39 02 29.5	82 45 42.0
Road southwest; 33 feet southwest to cross on corner fence post, 30 feet west to cross on corner fence post	39 03 29.0	82 46 38.5
Bethel Church, T road east at; 22 feet north to mail box, 27 feet west to cross on rail fence	39 03 48.8	82 46 41.2

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Schoolhouse, intersection of roads just south of; 43 feet south to C. L. Grover's mail box, 15 feet southwest to cross on board fence	39 04 25.6	82 46 11.0
Vance's store, T road west 1.5 miles south of; 10 feet southwest to M. A. Harper's mail box, 18 feet east to cross on fence post	39 04 54.0	82 45 53.1
Vance's store or Eastbrooke, T road west; 15 feet northeast to door of store, 24 feet southwest to cross on front-yard gatepost	39 06 14.7	82 45 19.4
Bridge, road southeast; 27 feet to northeast corner of bridge; 15 feet northeast to cross on small sycamore tree	39 06 57.1	82 45 09.6
Limerick, in southeast corner of T. J. Beatty's garden, southeast corner of foundation to Beatty's residence bears N. 34° W., distant 81 feet; center of commissioners' plate on north truss of bridge over Pidgeon Creek bears south 63° 30′ E., distant 96.1 feet; iron bench-mark post set 40 inches in the ground, stamped "Prim. Trav. Sta. No. 19"	39 07 31.4	82 45 01.4
Limerick, intersection of roads 1.5 miles north of; 12 feet southwest to mail box, 27 feet northeast to cross on locust tree at corner of fence	39 08 43.6	82 45 08.1
Springer, T road east 1 mile southwest of; 20 feet northeast to cross on gatepost, 30 feet west to cross on board fence	39 09 46.5	82 45 54.1
Springer, T road west at; 30 feet west to cross on telephone pole, 50 feet southeast to cross on telephone pole.	39 10 20.9	82 44 45.2
McGill's store, intersection of roads; 40 feet northeast to east corner of bridge, 40 feet southwest to store door	39 11 15.1	82 45 04.5
Cemetery, intersection of roads about 400 feet east of; 18 feet east to cross on rail fence, 15 feet northwest to west end of small stone culvert	39 11 28.1	82 45 39.6
T road west at line between Jackson and Benton counties; 27 feet southwest to cross on walnut tree; 45 feet northwest to cross on corner fence post	39 12 27.6	82 45 39.0

Geographic positions along the Baltimore and Ohio Southwestern Railroad between West Junction and Vigo.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
West Junction, overhead road crossing about 0.25 mile east of	39 13 02.6	82 45 50.1
Milepost 111, road crossing 330 feet southeast of	39 13 58.3	82 46 52.9
Vigo station, road crossing north and south 90 feet southeast of	39 14 52.2	82 47 33.5

MAHONING AND TRUMBULL COUNTIES.

YOUNGSTOWN QUADRANGLE.

The following geographic positions were obtained by primary traverse run in 1904 by Mr. J. R. Ellis. A line starts from an adjusted position 5 miles east of Warren and follows highways east through

Paynes Corners to Sharon, where it ties to boundary monument No. 51 on Ohio-Pennsylvania State line. A line was also run west from Ohio-Pennsylvania State line boundary monument No. 65½ near Lowellville along highways near south border of quadrangle to Canfield.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Warren, U. S. B. M. Post No. 33, 5 miles east of	41 14 18.0	80 44 27.9
T road north at shops, 28 feet northwest to mail box, 42 feet northeast to blacksmith shop (southwest corner of)	41 14 12.8	80 42 45.7
Schoolhouse No. 7, T road north	41 14 17.8	80 41 24.3
Vienna crossroads; T. 4 N., R. 2. W., corner to secs. 17, 18, 27, and 28	41 14 15.9	80 39 49.7
Vienna, 1.5 miles east of; in northeast corner of Newman's farm at crossroads, nail in west part of large maple tree on north side of road bears N. 64° 20′ E., distant 110.4 feet, cross on south end stone culvert bears N. 75° 30′ W., distant 96.7 feet, iron post stamped "Prim. Trav. Sta. No. 41"	41 14 15.7	80 38 11.5
Paynes Corners, crossroads; 42 feet northwest to guidepost, 30 feet southwest to west end stone culvert	41 14 13.2	80 37 01.6
T. 4 N., R. 1 W., corner secs. 14 and 23, T road north, 19 feet northeast to east end of box culvert	41 14 09.2	80 35 50.2
Brookfield, T road north at, 33 feet northwest to guideboard on telephone pole, 36 feet south to iron pump	41 14 02.7	80 34 05.5
Schoolhouse, road northwest about 600 feet east of, 35 feet north to guidepost, 24 feet south to cross on fence	41 14 07.6	80 31 55.9
Sharon, Ohio-Pennsylvania State boundary monument No. 51 on High street in west part of	41 13 55.1	80 31 09.2
Ohio-Pennsylvania State line monument No. 65½	41 01 27.3	80 31 08.9
T. 1 N., corner secs. 49, 50, 55, and 57, T road north at schoolhouse	41 01 25.9	80 32 37.6
Crossroads at schoolhouse, corner to secs. 34, 35, 42, and 43, 36 feet southeast to guidepost, 33 feet northwest to post	41 01 25.5	80 34 03.2
T. 1 N., corner secs. 15, 16, 25, and 26, T road north, 24 feet northeast to mail box, 30 feet south to cross on corner fence post	41 01 25.1	80 35 29.5
Poland, T road northeast at Bishop's Hotel, 33 feet east to lamp-post, 39 feet north to hotel signpost	41 01 25.3	80 36 49.8
Poland, 1 mile west of; in southeast corner of Joseph Hitchcock's farm, at crossroads, iron guidepost bears S. 89° 25′ W., distant 58.6 feet; southwest corner of Hitchcock's residence bears S. 38° 15′ W., distant 173 feet, iron post stamped "Prim. Trav. Sta. No. 42"	41 01 27.5	80 38 04.0
Oakland, road crossing Youngstown Southern Railroad	41 01 27.6	80 39 18.3
Schoolhouse, T road north; 32 feet northwest to John Hitchcock's mail box, 20 feet northeast to northwest corner culvert	41 01 28.2	80 40 55.7
Canfield, crossroads 2½ miles east of; 19 feet southeast of mail box, 42 feet northwest to cross on fence post	41 01 28.7	80 42 40.8
Canfield, crossroads at schoolhouse 1.5 miles east of	41 01 29.0	80 44 13.2
Canfield, west end of water trough at crossroads	41 01 29.4	80 45 38.6

PENNSYLVANIA.

TRIANGULATION STATIONS.

JUNIATA AND PERRY COUNTIES.

LOYSVILLE AND HONEYGROVE QUADRANGLES.

Control for these two quadrangles was obtained in September, 1904, by Mr. George T. Hawkins, topographer, who extended triangulation westward from stations Newport and Peters. In addition to reoccupying these Mr. Hawkins selected, built, and occupied six new stations.

BIG KNOB, PERRY COUNTY.

On spur of Tuscarora Mountain, about 3 miles northwest of Blair, Pa. It is reached by going 1 mile on Newport road and turning to left through lane up to top of ridge by wood road, then going 1 mile west along ridge to signal.

Signal: Red-oak tree 8 inches in diameter.

Station mark: A bronze triangulation tablet cemeneted in solid rock.

Reference marks: The red-oak signal tree; true azimuth, 123° 55′; distance, 14 feet from station mark.

[Latitude 40° 21′ 37.42″. Longitude 77° 32′ 46.05″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Blair	52 47 07	232 41 32	4.18586
Shade	150 58 40	330 55 51	4.10210
Tuscarora	225 00 15	45 05 22	4.19821
Bowers	276 22 09	96 29 36	4.21447

BLAIR, FRANKLIN-JUNIATA COUNTY LINE.

(Not occupied.)

On a knob on the Tuscarora ridge, about 2 miles east of Blair, Pa. The knob was nearly cleared of timber and one tree left for signal, with white flag in top. The point is reached by going about 1.5 miles southeast on road from Blair to old sawmill, then up the mountain on foot.

Station mark: The lone signal tree.

[Latitude 40° 16′ 36.30″. Longitude 77° 41′ 23.18″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Shade	196 32 58	16 35 44	4.32693
Big Knob	232 41 32	52 47 07	4.18586

BOWERS, PERRY COUNTY.

About 3 miles southwest of Loysville by road, on land owned by Sam Waller, about 0.25 mile east of Waller's house. It is nearly 3 miles west by road from Landisburg, on east side of fence row between fields. It is much lower than surrounding timbered hills, but overlooks much of surrounding country.

Station mark: A marble post 6 by 6 by 30 inches set 24 inches in ground and resting on solid rock.

[Latitude 40° 20′ 37.92″. Longitude 77° 21′ 16.06″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Big Knob	96 29 36.00	276 22 09.00	4.21447
Tuscarora	158 34 55.74	338 32 35.58	4.14465
Eschol	206 00 35.75	26 03 00.42	4.0791292
Newport	237 09 00.95	57 17 39.23	4.3508360
Peters	264 24 56.20	84 35 54.16	4.3818308

ESCHOL, PERRY COUNTY.

In cleared field 100 yards west of road and 0.25 mile northwest of forks of road, 1½ miles southeast of village of Eschol, nearly 2 miles northwest of Mansville, and 4½ miles northeast of Elliottsburg.

Signal: A lumber tripod.

Station mark: A marble post 6 by 6 by 30 inches set 26 inches in the ground.

[Latitude 40° 26′ 27.46″. Longitude 77° 17′ 32.82″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bowers	26 03 00.42	206 00 35.75	4.0791292
Tuscarora	102 03 45.00	281 58 59.85	4.0248510
Newport	264 13 22.18	84 19 36.14	4.1352045

NEWPORT, PERRY COUNTY.

Situated on timbered ridge 2 miles south of Newport. The summit was cleared of timber and lone oak tree 8 inches in diameter was left standing on the highest point. It can be reached by following Duncannon road 1½ miles south from Newport to old sawmill site, thence southwest by trail to summit.

Station mark: Center of lone signal tree.

[Latitude 40° 27′ 11.6″. Longitude 77° 07′ 56.4″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bowers	57 17 39.23	237 09 00.95	4.3508360
Eschol	84 19 36.14	264 13 22.18	4.1352045
Tuscarora	92 06 37.12	271 55 37.90	4.3793545
Millerstown	167 04 02.00	347 02 41.00	4.11684
Spruce	217 36 06.00	37 39 10.00	4.03919
Peters	332 33 37.00	152 35 57.00	4.04464

PETERS, PERRY COUNTY.

Situated on Peters Mountain, about 4 miles west of Duncannon; about 2 acres cleared of timber and lone pine tree 24 inches in diameter left standing for signal.

Station mark: A copper bolt cemented in solid rock.

Reference mark: The lone signal tree, true azimuth 331° 09′, 4 feet distant.

[Latitude 40° 21′ 52.7″. Longitude 77° 04′ 19.9″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bowers	84 35 54.16	264 24 56.20	4.3818308
Tuscarora	110 17 38.74	290 04 20.12	4.4907718
Newport	152 35 57.00	332 33 37.00	4.04464
Spruce	184 53 30.00	4 54 14.00	4.26888

SHADE, MIFFLIN-JUNIATA COUNTY LINE.

On Shade Mountain, on land owned by Alexander Anderson, about 2 miles northwest of Reedsgap post-office and about 3 miles nearly west of McCoytown. Timber on summit. Go from Reedsgap 0.75 mile, then turn along road to right opposite signal and walk to top.

Signal: Hickory tree 20 inches in diameter.

Station mark: A bronze tablet cemented in solid rock.

[Latitude 40° 27′ 35.98″. Longitude 77° 37′ 06.54″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Blair	16 35 44	196 32 58	4.32693
Tuscarora	269 37 42	89 45 38	4.23803
Big Knob	330 55 51	150 58 40	4.10210

TUSCARORA, JUNIATA-PERRY COUNTY LINE.

On summit of Tuscarora Mountain 5 miles by road from Ickesburg. To reach signal go from Ickesburg on Port Royal road to fork of road near summit, and 0.25 mile above spring take left hand and follow top of ridge along old wood road to signal. Instrument elevated 38 feet.

Station mark: Pine tree with target on top. One hundred feet north of wood road.

Reference mark: A bronze tablet 8 feet due northeast of signal tree.

[Latitude 40° 27′ 38.97″. Longitude 77° 24′ 52.32″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Big Knob	45 05 22.00	225 00 15.00	4.19821
Shade	89 45 38.00	269 37 42.00	4.23803
Newport	271 55 37.90	92 06 37.12	4.3793545
Eschol	281 58 59.85	102 03 45.00	4.0248510
Peters	290 04 20.12	110 17 38.74	4.4907718
Bowers	338 32 35.58	158 34 55.74	4.14465

FRANKLIN COUNTY.

SHIPPENSBURG QUADRANGLE.

In August, 1904, Mr. George T. Hawkins selected and occupied three new triangulation stations for the control of this quadrangle, based upon Chambersburg and Parnell United States standard datum.

CHAMBERSBURG, FRANKLIN COUNTY.

The balcony of the clock tower on the county court-house at Chambersburg was occupied, and the angles were reduced to center of tower.

Station mark: Center of clock tower.

[Latitude 39° 56′ 15.41″. Longitude 77° 39′ 39.62″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Strasburg	149 15 58.62	329 12 37.23	4.1623856
Roxbury	182 36 06.00	2 36 35.00	4.37343
Timber Hill	227 17 34.80	47 22 24.60	4.1629694
Parnell	82 25 31.4	262 17 45.3	4.2405209
Quirauk	334 33 43.9	154 39 25.8	4.4715130
Alto	316 52 07.6	136 56 56.7	4.1954468

PARNELL, FRANKLIN COUNTY.

On mountain locally known by same name, about 9 miles west of Chambersburg and 3 miles east of Fort London.

Theodolite elevated 24 feet on top of stump of a tree; sight lines were cut through timber to other stations.

Station mark: A bronze tablet stamped "U. S. Geological Survey—Pennsylvania," cemented in solid rock.

[Latitude 39° 55′ 00.42″. Longitude 77° 51′ 45.82″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Fairview	17 36 22.3	197 32 15.8	4.4822860
Cove	44 49 11.6	224 41 37.6	4.3790001
Pike	88 07 15.8	268 03 34.2	3.9142524
Chambersburg	262 17 45.3	82 25 31.4	4.2405209
Alto	287 59 23.8	108 11 58.4	4.4687745
Quirauk	309 04 53.8	129 18 20.6	4.5874493
Martin	340 38 14.6	160 42 52.2	4.4941249
Strasburg	213 27 30.29	33 31 55.57	4.2491919
Timber Hill	246 20 39.85	66 33 16.13	4.4839373

ROXBURY, FRANKLIN COUNTY.

(Not occupied.)

On the first ridge northwest of valley on well-known knob of that name. All timber was cleared from summit and one tree left for signal.

Station mark: Lone signal tree.

Reference mark: Tablet cemented in solid rock 4 feet southeast of signal.

[Latitude 40° 09′ 00.74″. Longitude 77° 38′ 54.28″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chambersburg	2 36 35	182 36 06	4.37343
Strasburg	37 25 40	217 21 49	4.14580
Timber Hill	324 59 40	145 04 01	4.22450

STRASBURG, FRANKLIN COUNTY.

On northeast end of long ridge 2 miles south of west from Upper Strasburg and 1 mile southeast of where road crosses mountain. Instrument elevated 35 feet.

Station mark: Tall black oak tree trunk used for theodolite support.

Reference mark: A cross on a stone post of the United States Coast and Geodetic Survey set in the ground 17.5 feet east of station mark.

[Latitude 40° 03′ 00.35″. Longitude 77° 44′ 52.97″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Parnell	33 31 55.57	213 27 30.29	4.2491919
Roxbury	217 21 49.00	37 25 40.00	4.14580
Timber Hill	278 10 33.96	98 18 45.67	4.2627043
Chambersburg	329 12 37.23	149 15 58.62	4.1623856

TIMBER HILL, FRANKLIN COUNTY.

On hill of same name about 1.5 miles south of Shippensburg on land owned by Mr. John Plaster.

Station mark: A lone hickory tree near west edge of a cleared field.

Reference marks: A cross cut in limestone, 11.4 feet distant from signal, bearing S. 38° W.

[Latitude 40° 01′ 35.22″. Longitude 77° 32′ 08.61″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Chambersburg	47 22 24.60	227 17 34.80	4.1629694
Parnell	66 33 16.13	246 20 39.85	4.4839373
Strasburg	98 18 45.67	278 10 33.96	4.2627043
Roxbury	145 04 01.00	324 59 40.00	4.22450

PRIMARY TRAVERSE.

LAWRENCE AND MERCER COUNTIES.

NESHANNOCK QUADRANGLE.

The following geographic positions were obtained by primary traverse run in 1904 by Mr. J. R. Ellis. The line starts from a position at Sharon on the Ohio-Pennsylvania State line and follows highways east to Mercer; thence south over highways and the Pennsylvania Railroad through Volant to McCaslin; thence west over highways through Newcastle and Edinburg, and ties to Ohio-Pennsylvania State line monument, No. 65½, at Lowellville.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Sharon, Ohio-Pennsylvania State line monument No. 51.	41 13 55.1	80 31 09.2
Sharon, T road south at Baptist Church in east part of...	41 13 59.0	80 29 11.3
Sharon, crossroads 2 miles east of; 30 feet southeast to guidepost	41 13 59.8	80 28 17.5
Sharon, T road near schoolhouse, 3 miles east of; 30 feet northwest to corner fence post, 24 feet northeast to W. Kerr's mail box	41 14 00.0	80 27 21.9
Sharon, crossroads 4 miles east of; 40 feet southwest to to guidepost, 25 feet northeast to D. De Forests' mail box	41 14 07.6	80 25 58.9
T road north, 12 feet southeast to mail box, 30 feet northeast to cross on telephone pole	41 14 11.2	80 25 05.7
Crossroads, 25 feet southwest to pump, 40 feet northeast to signboard	41 14 15.7	80 24 20.5
T road south, 22 feet southwest to west end of culvert ...	41 14 14.4	80 23 15.8
Charleston, crossroads 0.75 mile west of; 20 feet northwest to Reno's mail box, 30 feet northeast to cross on telephone pole	41 14 14.7	80 22 27.1
Hill or Charleston, on property of Mrs. Mary Buchanon; cross on northeast corner of stone foundation Buchanon Hotel bears S. 2° 45′ E., distant 17.6 feet; southeast corner of stone foundation to E. A. Beals's store bears N. 54° 10′ W., distant 110.5 feet; in top of sandstone post, aluminum tablet stamped "Prim. Trav. Sta. No. 1"	41 14 13.4	80 21 37.3
Charleston, crossroads 1 mile east of; 36 feet southwest to guidepost, 25 feet southeast to south end of culvert..	41 14 06.3	80 20 26.0
Road south, 20 feet north to property of W. H. Wallace, 30 feet southwest to west end of culvert	41 14 02.5	80 19 33.2
Mercer, crossroads 3.75 miles east of; 27 feet north to guidepost, 22 feet southwest to cross on telephone pole.	41 14 02.8	80 18 24.1
T road north, 30 feet northwest to cross on rail fence, 24 feet south to cross on west rail fence post	41 13 39.5	80 16 49.3
Mercer, T road north 1.25 miles west of; 27 feet south to cross on gate; 30 feet northeast to cross on rail fence...	41 13 33.6	80 15 54.4
Mercer, in Mercer County C. H., tablet No. 2	41 13 37.1	80 14 20.0
T road west, 30 feet southeast to corner fence post, 42 feet southwest to maple tree	41 12 44.0	80 14 15.7
Hope Mills, road crossing north and south	41 12 27.5	80 13 39.4

Geographic positions along the Pennsylvania Railroad between Milburn and Volant.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Private road crossing	41 10 50.3	80 13 53.8
Milburn, road crossing east and west	41 10 07.0	80 13 38.9
Standard oil pump station, road crossing northeast and southwest	41 09 26.8	80 13 50.3
Banbury, road crossing at station	41 08 33.9	80 14 25.2
Private road crossing, 1,330 feet north of spur	41 07 53.8	80 14 27.1
Volant, in southeast corner of B. Hemstreet's garden; cross on northeast corner of foundation to N. W. Aller's stable bears S. 15° 30′ W., distant 22.9 feet; cross on northwest corner of foundation to stable bears S. 59° 45′ E., distant 112.9 feet; iron post stamped "Prim. Trav. Sta. No. 5"	41 06 50.9	80 15 28.7

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
State road crossing and road east and west	41 05 41.0	80 15 48.7
Rich Hill schoolhouse, crossroads 0.5 mile south of; 30 feet northwest to fence post, 27 feet southwest to corner yard fence	41 04 50.2	80 15 53.9
Volant, T road 3.5 miles south of; 27 feet northwest to guidepost, 42 feet to cross on large sugar-maple tree	41 03 53.6	80 15 57.2
Esterbrook, crossroads 0.5 mile east of; 40 feet southeast to guidepost, 40 feet northwest to Smith's mail box	41 02 42.2	80 16 03.4
Crossroads, 24 feet southwest to guidepost, 21 feet southeast to W. Warnock's mail box	41 01 56.7	80 15 30.9
McCaslin, in northeast corner of J. A. Hickathorn's property, southwest corner of Houck's store bears S. 23° 25′ E., distant 206 feet; cross on northeast corner of foundation to J. L. Hickathorn's house bears S. 34° 45′ W., distant 206.5 feet; in sandstone post, aluminum tablet stamped "Prim. Trav. Sta. No. 6"	41 00 49.4	80 15 25.6
McCaslin, T road south 1.5 miles west of; 36 feet southwest to letter box, 36 feet southeast to cross on corner fence post	41 00 44.7	80 17 03.8
Schoolhouse, road north 0.25 mile west of	41 00 37.7	80 18 45.4
Newcastle, in southeast corner of base to north meridian stone in court-house yard; south meridian stone bears due S. 119.1 feet distant; aluminum tablet stamped "Prim. Trav. Sta. No. 7"	40 59 55.6	80 20 22.0
Newcastle, crossing of West Grand avenue and Locust street; center of station car tracks	41 00 11.5	80 21 19.8
Newcastle, crossroads at schoolhouse 1 mile west of; 45 feet southeast to guidepost, 27 feet northwest to United States letter box	41 00 23.5	80 22 37.8
Summit schoolhouse, road north just west of	41 00 40.1	80 23 31.3
Newcastle, crossroads 3 miles west of; 27 feet southwest to telephone pole, 27 feet northeast to cross on telephone pole	41 00 58.8	80 24 24.0
Road north, 12 feet north to John Haney mail box, 45 feet northwest to John Pfeils mail box	41 01 15.8	80 25 10.4
Edenburg, crossroads 1 mile north of; 36 feet southwest to guidepost; 43 feet southeast to cross on telephone pole	41 01 32.1	80 26 01.6

Geographic positions along the Pennsylvania Railroad.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Hillsville and Edenburg, road crossing of Pennsylvania Railroad	41 00 48.1	80 26 36.6
Private road crossing	41 01 07.9	80 27 40.3
Hillsville, road crossing	41 01 09.4	80 29 21.6
Quaker Creek, road crossing south of bridge over	41 01 35.9	80 30 23.8
Ohio-Pennsylvania State line monument No. 65½	41 01 27.3	80 31 08.9

CUMBERLAND, DAUPHIN, AND YORK COUNTIES.

NEW CUMBERLAND QUADRANGLE.

The following geographic positions were obtained from primary traverse run in 1905 by Mr. J. R. Ellis. The line starts from a position at York located in 1899 by primary traverse, and follows north along the Northern Central Railroad to Middletown and north over highways to Rutherford station; thence west over the Philadelphia and Reading Railroad to Harrisburg; thence southeast along highways to Mechanicsburg; thence south along highways, and connects with Round Top triangulation station (Coast and Geodetic Survey); continues south to Hall; thence east along highways through Dover to starting point at York.

Geographic positions along the Northern Central Railroad between York and Middletown.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
York, south meridian stone; in Pennsylvania Park. Station mark: A sandstone post 40 by 6 by 6 inches, having a bronze tablet cemented in its top, set 36 inches in ground, 430 feet east of center of Water street and 57 feet north of center of Fulton street	39 57 20.1	76 43 36.8
York, Pennsylvania Railroad crossing, at York Chemical Works (west track)	39 58 32.8	76 43 21.0
Cordons Creek, center pier of bridge over	39 59 51.0	76 43 18.7
Road crossing under trestle No. 100	40 00 31.5	76 42 57.0
Emigsville station	40 01 12.3	76 43 38.1
Overhead crossing	40 02 22.3	76 43 18.5
Mount Wolf station	40 03 54.2	76 42 32.7
Road crossing under trestle 116	40 04 48.2	76 41 56.9
Junction with cut off to Philadelphia	40 05 36.2	76 42 02.9
York Haven, road crossing at station	40 06 40.6	76 42 45.8
Cly post-office, in southeast corner of foundation, bronze tablet stamped "Prim. Trav. Sta. No. 1, 1905"	40 07 20.7	76 44 04.0
Milepost 67	40 08 04.3	76 44 44.4
Goldsboro station	40 09 14.0	76 44 56.6
Middletown Ferry station, road crossing 0.5 mile south of	40 10 14.6	76 45 07.2
Middletown, southwest corner of National Tube Co.'s pumping station	40 11 16.3	76 44 42.2

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Middletown, crossing of Emans and Union streets	40 11 42.1	76 43 53.1
Coble schoolhouse, forks of road	40 12 46.4	76 44 08.6
Ulrichs Corners, crossroads, 21 feet northwest to cross on corner fence post; 25 feet northeast to cross on corner fence post	40 13 48.0	76 44 17.0
Elbow Farm, in southwest corner of Adam Greigrich's stone outhouse, cross and "U. S. G. S." cut in, primary traverse station No. 2	40 14 48.8	76 44 09.8
T road south, at Ray Delanoe's residence, 27 feet southwest to cross on telephone pole, 32 feet southeast to corner yard fence	40 15 37.5	76 44 55.1

Geographic positions along the Philadelphia and Reading Railroad between Rutherford and Harrisburg.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Rutherford station, overhead road crossing 0.75 mile east of	40 15 47.3	76 46 41.7
Rutherford station, road crossing 50 feet south of waiting shed	40 15 33.3	76 47 38.4
Overhead road crossing	40 15 17.4	76 48 31.7
Paxtang station, road crossing 50 feet east of	40 15 28.1	76 49 55.6
Harrisburg, Ninth street overhead crossing	40 15 27.0	76 51 22.6

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Harrisburg, in southeast corner of State Library, aluminum tablet stamped "Prim. Trav. Sta. No. 3;" elevation 364	40 15 48.2	76 53 00.6
Harrisburg, south end of Water street bridge	40 15 01.1	76 53 28.3
Camp Hill, electric railway tracks at T road south, at top of hill	40 14 24.6	76 54 48.0
Crossroads at turn of electric railway	40 14 23.6	76 56 05.7
St. John's Church, crossroads 0.5 mile northwest of; 63 feet southeast to guidepost, 27 feet northeast to cross on board fence	40 14 16.0	76 57 40.2
Road south, 45 feet south to mailbox, 25 feet southwest to cross on corner fence post	40 14 24.1	76 58 59.7
Salem Methodist Church, in north end of stone wall at northwest corner of, stamped "Prim. Trav. Sta. No. 4, 1905"	40 14 43.9	76 59 56.4
Mechanicsburg, T road northwest 1 mile northeast of	40 13 45.9	76 59 39.3
Mechanicsburg, in brick high school, bronze tablet stamped "Prim. Trav. Sta. No. 5, 1905;" elevation 456	40 12 40.1	77 00 41.0

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Y road south, 16 feet east to telephone pole, 24 feet southwest to cross on board fence	° ′ ″ 40 12 09.9	° ′ ″ 77 00 00.2
Graham schoolhouse, crossroads	40 11 31.1	76 59 30.3
Shepherdstown, crossroads 0.25 mile northeast of; 35 feet south to guidepost, 19 feet east to north end of culvert	40 10 48.3	76 59 22.8
Brumarsdale, Philadelphia and Reading overhead crossing 400 feet west of station	40 09 58.0	76 58 41.3
Siddonsburg, crossroads, 21 feet east to guidepost, 24 feet northwest to southeast corner of post-office	40 08 46.5	76 57 57.9
Monagham, in north corner of foundation to Church of God, bronze tablet stamped "Prim. Trav. Sta. No. 6"	40 08 11.4	76 57 48.2
Meyers schoolhouse, crossroads, 19 feet south to mailbox, 36 feet northeast to guidepost	40 07 30.5	76 56 31.7
Round Top triangulation station: Of the United States Coast and Geodetic Survey in Warrington Township, 8 miles east of Dillsburg. Station mark: A sandstone post 18 by 6 by 6 inches set 15 inches in ground and resting on a flat rock having cross lines cut on its upper surface	40 06 13.24	76 55 34.14
Beaver Creek, west end of bridge over	40 05 32.0	76 55 58.8
T road south at schoolhouse	40 05 19.4	76 56 54.4
Crossroads, guidepost	40 04 11.2	76 57 10.9
Mount Pleasant schoolhouse, T road east just north of, 27 feet northeast to guidepost, 33 feet southeast to end of wire fence	40 03 37.7	76 57 57.4
Crossroads	40 03 11.6	76 58 10.8
Hall, guidepost at crossroads, 1 mile northwest of	40 02 06.6	76 59 20.4
Hall, in southwest corner of stone wall of Dr. F. Shelley's front yard, bronze tablet stamped "Prim. Trav. Sta. No. 7"	40 01 11.2	76 58 57.3
Bermudian Creek, northwest end of covered bridge over	40 00 30.6	76 57 46.9
Road northeast, 300 feet south of schoolhouse	39 59 16.3	76 56 58.1
Steel bridge, west end of	39 59 15.5	76 55 54.1
Davidsburg, T road north just west of hotel	39 59 00.9	76 53 40.5
Davidsburg, crossroads 1 mile east of, 21 feet northwest to guidepost, 18 feet south to cross on post	39 58 56.0	76 52 18.2
Salem Church, road southeast	39 59 25.2	76 51 33.2
Dover, in stone foundation to White Hall Hotel just east of ladies' entrance, bronze tablet stamped "Prim. Trav. Sta. No. 8"	40 00 04.1	76 51 00.9
Road southwest, 21 feet south to guidepost, 18 feet southwest to east end of culvert	39 59 02.1	76 49 26.1
Katz Mill, east end of iron bridge over Little Conewago Creek	39 58 50.2	76 48 23.9
Blacksmith shop, road southwest	39 58 34.4	76 47 32.0
Road southwest, 22 feet south to guidepost, 19 feet north to cross on telephone pole	39 57 48.0	76 45 56.6
York, Carlyle road crossing of Pennsylvania Railroad	39 57 28.0	76 44 56.5

MERCER COUNTY.

STONEBORO QUADRANGLE.

This line starts at Mercer and runs northward along highways and is tied to a point 5 miles east of Atlantic, located by Mr. C. B. Kendall in 1903.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Mercer, in top step at northeast corner of porch to north entrance of Mercer County court-house; aluminum tablet stamped "Prim. Trav. Sta. No. 2"	° ′ ″ 41 13 37.1	° ′ ″ 80 14 20.0
Mercer, north part of; center of bridge at road intersection	41 14 04.8	80 14 17.0
Mercer, crossroads, 2 miles north of; 37 feet southwest to guidepost, 18 feet northwest to west end of culvert	41 15 31.5	80 14 19.6
T road east, 20 feet west to cross on apple tree, 40 feet southeast to cross on fence post	41 16 34.2	80 14 21.1
Mercer, crossroads 5 miles north of; 40 feet east to road crossing of Pennsylvania, Bessemer and Lake Erie Railroad, 30 feet northwest to signboard	41 17 51.8	80 14 23.6
Fairview, Y road 1.5 miles south of; 45 feet northwest to cross on gatepost; 39 feet east to guidepost	41 18 24.3	80 14 03.7
Fairview, T road east; 27 feet southeast to guidepost; 30 feet northwest to James Gamble's mail box	41 19 34.1	80 13 48.7
Fairview, T road east 0.5 mile east of; 18 feet southeast to James Welch's mail box; 37 feet northeast to cross on black oak tree	41 20 32.3	80 13 36.4
T road east; 25 feet southeast to guidepost, 17 feet west to cross on board fence	41 21 27.2	80 13 24.8
Hadley, 3 miles south of; in northwest corner of F. R. McDowell's orchard; at southwest corner of yard on Pittsburg and Erie Road; nail in root of wild cherry tree on northwest side of road bears N. 74° 15′ W., distant 52 feet; southwest corner of foundation to F. R. McDowell's residence bears N. 69° E., distant 46 feet; iron post stamped "Prim. Trav. Sta. No. 3"	41 22 42.1	80 13 08.3
Road northwest, 15 feet northwest to cross on board fence, 37 feet east to guidepost	41 23 52.3	80 12 53.2
Hadley, road crossing of Lake Shore Railroad 1 mile east of	41 24 36.3	80 12 47.3
Sheakleyville, T road west 1 mile south of; 40 feet southwest to guidepost; 21 feet northwest to west end stone culvert	41 25 30.7	80 12 34.8
Sheakleyville, road west at Baptist Church, 33 feet northwest to iron fence; 63 feet west to northeast corner of Baptist Church	41 26 49.0	80 12 24.3
T road east, 40 feet east to McCrakers mail box; 36 feet south to cross on gatepost	41 27 55.8	80 12 26.8
Boutner schoolhouse, crossroads 0.25 mile south of	41 28 30.7	80 12 48.1
Boutner schoolhouse, T road south at; 21 feet north to cross on board fence, 35 feet southwest to guidepost	41 29 32.5	80 13 08.2

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Williams (Fred), in southwest corner of his orchard; at northwest corner of yard; north corner of foundation to residence bears S. 28° 30′ E., distant 47.8 feet; west corner of foundation to same bears S. 1° 25′ W., distant 64.1 feet, in top of marble post, aluminum tablet stamped "Prim. Trav. Sta. No. 4"	° ′ ″ 41 29 53.5	° ′ ″ 80 14 18.7
Atlantic, crossroads 5 miles east of	41 30 23.1	80 14 17.8

SOUTH CAROLINA.

PRIMARY TRAVERSE.

CHESTER, UNION, AND YORK COUNTIES.

BLAIRSVILLE AND ROCKHILL QUADRANGLES.

The following geographic positions were determined by primary traverse in 1905 by Mr. C. B. Kendall, field assistant. The line starts from an adjusted position on the United States standard datum at Fort Mill, follows wagon roads and railroads west, south, east, and north near borders of quadrangle and checks on itself at Fort Mill. Starting again at Yorkville, it follows highways and railroad west, south, and east near borders of the Blairsville quadrangle and checks on point on the Rockhill line.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Bridge, southwest end of, at forks of road	35 00 34.1	80 58 18.0
Catawba River bridge; middle of center span	35 00 27.8	80 59 56.6
Church, four corners, 15 feet north to double pine, 25 feet southeast to hickory	35 00 27.5	81 01 17.5
Forks of roads north and west, 20 feet southwest to peach tree	35 01 03.5	81 02 33.8
Four corners, 500 feet north of church	35 00 40.2	81 03 41.1
Belmont, 0.75 mile west of; four corners, 30 feet south to mail box	35 00 30.0	81 04 41.7
T road north, 200 feet south of Smith's store	35 00 31.7	81 06 04.5
Newport, 150 feet south of station; 600 feet west of milepost 106, between 2 stores, iron post stamped "Prim. Trav. Sta. No. 1, 1905"	34 59 22.1	81 05 58.3

Geographic positions along Southern Railway, Newport via Yorkville to Chester.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Newport, road crossing 1.25 miles west of	34 59 44.8	80 06 58.8
Tirzah, 200 feet west of station, road crossing	34 59 47.8	81 08 33.9
Road crossing, center of track	34 59 52.8	81 10 15.8
Trestle over second-class road	35 00 10.3	81 11 46.9
Yorkville, 1 mile east of; road crossing	34 59 49.7	81 13 22.3
Yorkville, East Liberty street crossing Southern Railway.	34 59 26.8	81 14 07.1
Yorkville, street crossing 75 feet south of station, Carolina and Northwestern Railway	34 59 34.4	81 14 23.6
Yorkville, in north face at northeast corner of Methodist Church, aluminum tablet stamped "Prim. Trav. Sta. No. 2, 1905"	34 59 34.0	81 14 24.8
North end of girder bridge of Carolina and Northwestern Railway over Southern Railway	34 58 46.6	81 14 45.7
Road crossing, center of track	35 57 29.5	81 14 21.6
Road crossing 570 feet north of milepost 20, center of track	34 56 51.3	81 14 07.8
Delphia, road crossing at station	34 56 12.2	81 13 31.5
Road crossing, center of track	34 54 38.0	81 12 31.3
Guthriesville, 300 feet southwest of station; 200 feet west of center of Carolina and Northwestern Railway track, in east face of chimney of north end of M. G. Guthrie's residence, aluminum tablet stamped "Prim. Trav. Sta. No. 3, 1905"	34 53 46.7	81 12 25.7
Milepost 15, 400 feet south of; center of track at second-class road crossing	34 52 56.4	81 12 56.7
McConnellsville, 30 feet south of mail crane, road crossing, center of main track	34 52 06.1	81 13 36.6
McConnellsville, 1.25 miles south of; road crossing, center of main track	34 51 32.5	81 14 22.3
Road crossing	34 49 41.8	81 14 54.4
Lowrysville, 50 feet east of station; road crossing	34 48 14.7	81 14 18.5
Lowrysville, 100 feet southeast of station, 60 feet south of main track, Carolina and Northwestern Railway, in north wall at northwest corner of brick store of J. L. Ahel, bronze tablet stamped "Prim. Trav. Sta. No. 4, 1905"	34 48 14.2	81 14 18.7
Road crossing 1 mile south of Lowrysville, center of track.	34 47 59.8	81 13 13.6
Milepost 6, 430 feet south of, at forks of road; center of track at road crossing	34 47 12.5	81 12 10.5
Milepost 4, 900 feet northwest of; road crossing	34 45 46.0	81 11 52.3
Airlee station, 50 feet south of; road crossing, center of track	34 44 50.8	81 11 56.7
Chester, 1.25 miles north of; center of track at road crossing	34 43 15.7	81 12 16.0
Chester, 0.75 mile north of; crossing of Seaboard Air Line and Carolina and Northwestern railroads	34 42 55.2	81 12 11.4
Chester, in front of ticket office; center of main track, Southern Railway	34 42 16.9	81 12 14.5

Geographic positions along Seaboard Air Line between Chester and Rodman.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Main track, Southern Railway at street crossing, 200 feet south of center of railway	34 42 14.6	81 12 14.8
Chester, in north wall at northwest corner of the Nicholson Hotel; bronze tablet stamped "540, Columbia, 1900;" "Prim. Trav. Sta. No. 5, 1905"	34 42 14.3	81 12 13.7
Second-class road crossing, center of track	34 43 22.6	81 10 41.6
Milepost 40, road crossing, 200 feet west of; center of track.	34 44 08.4	81 08 22.9
Second-class road crossing, 800 feet east of water tank; center of track	34 44 34.6	81 07 31.8
Rodman, 1.25 miles west of; center of track, road crossing.	34 45 31.2	81 06 22.4

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Rodman, post-office, 300 feet south of Seaboard Air Line station, at northwest corner of store of S. J. Lewis; iron post stamped "Prim. Trav. Sta. No. 12, 1905"	34 46 05.1	81 05 09.0
Second-class road to northeast	34 45 57.3	81 04 00.7
Grove Church, four corners, 300 feet southwest of; crossroads, 15 feet west to mail box, 50 feet east to tree	34 45 34.6	81 03 12.7
Four corners, second-class road, 10 feet southeast to mail box	34 46 12.7	81 02 34.3
Lando, forks of road near top of hill, roads southwest and west, 60 feet east to milepost "Col. 61"	34 46 27.3	81 00 46.2
Second-class T road to south, 30 feet northeast to two oaks, 30 feet northwest to three persimmons	34 46 41.4	80 59 04.4
Lando, 2.6 miles southeast of, at junction of Chester, Landsford and Rockhill-Wylis Mills roads; iron post stamped "Prim. Trav. Sta. No. 13, 1905"	34 46 39.6	80 58 08.4
Three-corner junction with Landsford road at schoolhouse, 10 feet southwest to pine tree	34 47 51.8	80 58 01.0
Collins, forks of road at milepost 22, 25 feet southwest to milepost, 20 feet southeast to oak tree	34 48 48.5	80 58 18.7
Seaboard Air Line Railway under crossing of Yorkville and Landsford road	34 49 50.3	80 58 43.1
Four corners intersection Yorkville-Landsford and Columbia-Notinford roads, 10 feet south to posts	34 50 21.7	80 59 23.4
Forks of road southwest and northwest, 30 feet west to mail box, 10 feet north to small pine	34 51 47.7	80 58 11.5
Leslie, 0.5 mile south of; forks of road north and northeast.	34 53 21.8	80 57 37.7
Leslie, 200 feet east of station, at northwest corner of Hemphill Hayes's store; iron post stamped "Prim. Trav. Sta. No. 14, 1905"	34 53 24.5	80 57 21.8
Rockhill, 3.5 miles east of, roads east and north at blacksmith shop, 25 feet to car shop, 40 feet southwest to telephone pole	34 54 36.6	80 58 07.9
Forks of road north and east, Indian Nation road to east	34 55 19.0	80 57 42.5
Second-class road to east at well, 40 feet southeast to well	34 56 31.6	80 57 19.9

Geographic positions along Southern Railway near Grattan.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Catawba River station, center of main track Southern Railway at road crossing	34 57 34.4	80 57 45.9
Grattan, 100 feet south of station; road crossing	34 58 55.0	80 56 58.3

Geographic positions along the Southern Railway between Yorkville and Hickory.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Trestle over road, center of track over road	34 58 20.5	81 15 25.8
Overhead crossing Southern Railway, center of track under bridge	34 57 57.4	81 16 50.0
Road crossing, center of track	34 57 28.4	81 18 29.3
Sharon, east of; overhead road crossing, center of track under bridge	34 57 20.4	81 19 42.1
Sharon, 300 feet west of station; road crossing	34 57 08.7	81 20 27.4
Sharon, 300 feet east of station, 170 feet northwest of road crossing Southern Railway at forks of road; iron post stamped "Prim. Trav. Sta. No. 6, 1905"	34 57 09.8	81 20 29.0
Sharon, 1.25 miles west of; road crossing center of track.	34 57 23.0	81 21 46.7
Bullocks Creek, 1 mile west of; road crossing, center of track	34 57 38.8	81 23 54.1
Second-class road crossing, center of track	34 58 09.4	81 24 38.9

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Hickory, four corners, intersection of main streets, 50 feet east to old well, 40 feet northeast to telephone pole.	34 58 58.2	81 24 57.9
Forks of road west and southwest at church, 25 feet west to persimmon tree, 50 feet east to dead poplar	34 59 06.4	81 25 48.3
Top of hill at forks of roads east and southeast, 10 feet north to oak tree, 20 feet south to telephone pole	34 59 04.7	81 27 26.8
Smith's ford of Broad River, 1 mile east of, at northeast corne rof front yard fence to residence of J. T. Smith on top of hill; iron post stamped "Prim. Trav. Sta. No. 7, 1905"	34 59 03.4	81 28 08.9
Forks of road north and northeast, 30 feet south to pine, 10 feet west to persimmon tree	34 58 09.3	81 28 36.0
Three corners, second-class road to northwest at junction with Howells Ferry road, about 3 miles southwest of Hickory, 30 feet northwest to oak tree, 20 feet east to oak tree	34 57 39.0	81 27 31.1
Forks of roads southwest and west, 10 feet southwest to mail box, 20 feet southeast to stump in field	34 57 10.8	81 27 55.1
Forks of road southwest and west, junction of Bullocks Creek and Howells Ferry roads, 1 mile east of ferry	34 55 43.5	81 27 42.2

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
Howells Ferry, 0.25 mile west of; forks of roads southwest and west, 15 feet west to small bridge, 25 feet southwest to mail box	° ′ ″ 34 55 41.8	° ′ ″ 81 28 59.8
Thompson's mill, center of covered bridge over Thickerty Creek	34 54 51.5	81 29 45.6
Sunnyside post-office, 0.75 mile south of; junction of Spartanburg-Union road and road leading east to Pinkney Ferry, at southwest corner small stone house; iron post stamped "Prim. Trav. Sta. No. 8, 1905"	34 54 06.6	81 31 11.0
Forks of road, 90 feet east of store on top of hill; roads southwest and east, 90 feet west to corner store, 50 feet south to corner blacksmith shop	34 53 41.5	81 32 18.8
Skull Shoals, 0.75 mile north of; road to east on top of hill, 60 feet south to large oak, 50 feet northwest to dead oak	34 52 54.1	81 31 45.0
Skull Shoals Ferry, south landing of, across Pacolet River	34 52 30.7	81 31 55.9
Skull Shoals, 1.5 miles south of; forks of road south and southeast, 50 feet southeast to cedar tree	34 51 24.8	81 32 14.7
Four corners, crossroads, 15 feet southwest to persimmon tree	34 50 31.0	81 30 50.4
Forks of road, 350 feet southeast of store, roads south and southeast, 40 feet north to pine	34 50 05.3	81 30 31.4
Forks of road north and northwest, 10 feet east to pine	34 48 35.3	81 29 53.1
South rail at southwest end of Lockhart Railroad crossing of road at Mount Tabor	34 47 47.7	81 30 10.7
Mount Tabor, 2 miles southeast of; four corners, second-class road, 15 feet southeast to oak, 35 feet northeast to pine	34 46 27.1	81 29 46.8
Second-class T road to northeast	34 45 47.7	81 29 39.6
Wortheys Ferry over Broad River, three corners west of; junction of Chester, Union, and road north to Mount Tabor	34 44 31.1	81 29 36.3
Wortheys Ferry, 0.5 mile west of; in northwest corner of junction of Chester, Union, and road leading to Mount Tabor, iron post stamped "Prim. Trav. Sta. No. 9, 1905"	34 44 31.6	81 29 36.5
Second-class road to south at top of clay hill, 10 feet south to small oak, 50 feet east to top of hill	34 44 00.9	81 28 17.2
Top of hill at second-class road to south, 35 feet north to oak stump, 50 feet southeast to pine	34 44 26.0	81 27 08.2
Summit of hill at second-class road to south	34 44 36.2	81 25 35.5
Wilkesburg post-office, intersection of roads at southeast corner of store of George W. Byars, iron post stamped "Prim. Trav. Sta. No. 10, 1905"	34 44 38.2	81 23 53.8
Forks of road, 300 feet southeast of milepost 11, roads southeast and south, 30 feet northwest to oak tree	34 44 34.2	81 22 02.2
Forks of roads west and northwest, 50 feet west to telephone pole, 40 feet south to black gum bush	34 44 57.8	81 20 37.1
South end of small bridge at forks of roads east and southeast	34 44 50.8	81 19 12.9
Three corners, second-class T road to southwest, 50 feet southwest to mulberry tree	34 44 09.5	81 18 22.4

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Four corners west of Chester, center of road	34 43 17.9	81 17 42.5
Chester, 5 miles west of; 0.5 mile west of bridge over Walkers Mill Creek, in southwest corner of crossroads, iron post stamped "Prim. Trav. Sta. No. 11, 1905"	34 43 17.8	81 17 42.9
Walkers Mill Creek, second class crossroads 0.25 mile east of; 50 feet north to pine, 60 feet southeast to telephone pole	34 43 10.8	81 16 53.6
Chester, four corners 4 miles west of; crossroads, 40 feet east to telephone pole	34 42 42.6	81 16 12.6
Wilkesburg road, overhead crossing Seaboard Air Line Railway	34 42 12.4	81 14 20.4

TENNESSEE.

PRIMARY TRAVERSE.

GILES, LAWRENCE, AND MAURY COUNTIES.

LAWRENCEBURG QUADRANGLE.

The following geographic positions were obtained by primary traverse run in 1904 by Mr. C. B. Kendall. The line starts from position at Columbia established from primary traverse by Mr. Gilbert Thompson, and follows south over the Louisville and Nashville Railroad through Pulaski to Prospect station; thence westward over highways to Iron City, where it ties to an adjusted position established by Mr. E. L. McNair in 1902. A line was also run west over highways from Wales through Lawrenceburg to Aarons Creek, tying to an adjusted position at that place.

Geographic positions along Louisville and Nashville Railroad between Columbia and Prospect stations.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Columbia (Thompson's station No. 6)	35 36 45.95	87 03 16.14
Columbia, crossing of Louisville and Nashville Railroad and South Main street 300 feet east of Union station	35 36 25.2	87 02 13.3
Overhead road crossing	35 35 47.5	87 01 27.9
Road crossing	35 34 45.4	87 00 58.3
Three corners, 15 feet east to center of railroad, 25 feet northeast to cedar tree with sign boards	35 34 12.9	87 00 20.6
Milepost 237, road crossing 600 feet south of	35 33 13.7	86 59 54.5
Glendale, road crossing 1 mile south of	35 31 35.8	86 59 15.8
Road crossing	35 30 56.8	86 59 15.3
Road crossing	35 30 18.6	86 59 15.8

Geographic positions along Louisville and Nashville Railroad between Columbia and Prospect stations—Continued.

Station.	Latitude.	Longitude.
Pleasant Grove, in Mr. Wilkes's yard, 20 feet from west corner of house, iron post stamped "Prim. Trav. Sta. No. 49"	° ′ ″ 35 29 16.8	° ′ ″ 86 59 12.2
Road crossing	35 27 25.2	86 59 01.5
Road crossing	35 25 16.1	86 59 32.2
Dodson Gap, telegraph office	35 24 23.0	86 59 37.0
Road crossing	35 23 17.5	86 59 47.6
Lynnville, in southeast corner of south end of grass plot, iron post stamped "Prim. Trav. Sta. No. 91"	35 22 35.5	87 00 23.8
Lynnville, second-class road crossing 1 mile south of	35 21 33.2	87 01 12.6
Lynnville, road crossing 2 miles south of	35 21 05.7	87 01 22.5
Buford station, center of track	35 19 46.9	87 01 35.4
Buford station, road crossing 1 mile south of	35 18 46.6	87 01 32.1
Reynolds station, overhead road 800 feet south of	35 17 58.5	87 01 42.3
Riversburg, road crossing 450 feet south of	35 16 37.8	87 02 40.8
Riversburg, road crossing 2 miles south of	35 15 57.0	87 04 21.7
Wales, 500 feet south of station, center of main track	35 14 56.2	87 04 58.5
Wales, road crossing 1 mile east of	35 14 00.1	87 04 38.7
Second-class road crossing	35 13 03.3	87 03 56.3
Second-class road crossing	35 12 34.1	87 03 39.5
Pulaski, in stone water table at southwest corner of Giles County court-house, aluminum tablet stamped "Prim. Trav. Sta. No. 148"	35 11 56.6	87 01 54.8
Pulaski, road crossing 600 feet south of station	35 11 28.0	87 02 13.9
Road crossing	35 09 44.9	87 01 51.0
Road crossing	35 09 07.1	87 01 23.9
Second-class road crossing	35 07 51.1	87 00 41.3
Richland Creek, in east end of north abutment of Louisville and Nashville Railroad bridge over, tablet stamped "Prim. Trav. Sta. No. 176"	35 06 48.2	87 00 19.5
Aspen Hill, road crossing 100 feet south of	35 06 02.4	87 00 15.0
Lester tunnel, north end of	35 04 32.4	87 00 19.4
Lester station, road crossing 350 feet south of	35 04 08.5	87 00 21.2
Prospect, road crossing 1 mile north of	35 02 45.4	87 00 17.9
Prospect, in north end of culvert 350 feet south of station; aluminum tablet stamped "Prim. Trav. Sta. No. 197"	35 01 39.0	87 00 11.2

Geographic positions along highways between Prospect station and St. Joseph.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Prospect, forks of road 1 mile west of	35 01 34.4	87 01 12.6
Schoolhouse, three corners at	35 01 [illegible]8.6	87 02 06.4
Bethel, three corners 1.25 miles east of	35 00 42.1	87 02 11.3
Bethel, four corners at; 20 feet northwest to corner of store, 45 feet west to corner of store	35 00 03.9	87 03 16.2
Forks of road, large oak at	34 59 52.4	87 04 13.0
Alabama-Tennessee State line	34 59 44.4	87 05 10.3
Little Shoal Creek, center of ford	34 59 36.8	87 05 18.1
Level Bottom schoolhouse, at four corners; 40 feet west of southwest corner of schoolhouse; iron post stamped "Prim. Trav. Sta. 293"	35 00 15.2	87 06 06.7
Top of hill, four corners at	34 59 47.8	87 07 22.4
Alabama-Tennessee State line	34 59 47.3	87 07 22.4
Haw (post-office), White's store, three corners; 50 feet west to gate, 45 feet northwest to store porch	35 00 35.0	87 08 15.7
Forks of road at bottom of hill	35 01 06.1	87 08 48.4
Sawmill, forks of road	35 00 51.1	87 09 52.9
Booths Chapel, forks of road 0.25 mile west of; 40 feet southwest to persimmon tree, 20 feet north to rail fence	35 01 33.3	87 10 42.6
Sugar Creek, three corners 0.5 mile west of bridge over, 20 feet west to mail-box post, 35 feet east to hazelnut tree	35 00 39.6	87 12 05.2
Three corners, road north; 50 feet south to creek bank, 25 feet northwest to cherry tree	35 01 17.2	87 12 32.1
Appleton, in foundation of south wall at southeast corner of store of Hall & Kelton; aluminum tablet stamped "Prim. Trav. Sta. No. 467"	35 01 24.9	87 14 01.8
Forks of road at foot of hill; 300 feet west of sawmill, 60 feet north to maple tree, 35 feet west to double iron-wood tree	35 01 02.3	87 14 33.4
Second-class road to southwest; 50 feet southwest to oak tree in angle	35 00 27.8	87 14 48.6
Second-class road to south; 25 feet east to oak tree, 35 feet north to rail fence	35 00 23.3	87 16 15.9
Crossroads, 50 feet south to oak tree, 40 feet north to oak tree	35 00 21.8	87 17 28.1
Forks of road east and north; 20 feet northwest to oak tree, 25 feet east to oak tree	35 00 19.1	87 19 19.0
Alabama-Tennessee State line, forks of road	35 00 04.5	87 20 16.6
Forks of road at top of hill	34 59 31.0	87 21 15.2
Lexington, three corners 0.75 mile northeast of	34 58 48.7	87 21 55.0
Lexington, at intersection of five forks; iron post stamped "Prim. Trav. Sta. No. 600"	34 58 11.4	87 22 16.8
Lexington, three corners 1 mile west of; 30 feet north to oak tree	34 58 33.8	87 23 20.2
Williams Mill, forks of road 200 feet south of	34 58 42.3	87 24 12.3
Sweet Gum schoolhouse, three corners 400 feet west of	34 58 51.7	87 25 01.0
Forks of road at sawmill	34 58 47.6	87 25 48.5

Geographic positions along highways between Prospect station and St. Joseph—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Belew post-office, three corners 150 feet south of store; 25 feet east to large oak tree, 40 feet southwest to rail fence	34 59 29.3	87 26 17.8
Forks of road, southeast and southwest; 10 feet west to rail fence, 35 feet east to hickory tree	34 59 43.3	87 26 57.8
Alabama-Tennessee State line (disputed)	35 00 08.45	87 28 08.8
Old Alabama-Tennessee State line	35 00 10.0	87 28 09.7
Crossroads, 35 feet south to dead oak tree, 50 feet east to oak tree and stump	35 00 35.7	87 28 26.5
Four corners, military road, north and south	35 00 55.9	87 29 12.9
Blue Water Creek	35 01 27.4	87 30 09.5
St. Joseph, four corners	35 02 02.6	87 30 17.4

Geographic positions along the Louisville and Nashville Railroad between St. Joseph and Iron City.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
St. Joseph, road crossing 400 feet west of	35 02 30.2	87 30 22.2
Milepost 288, road crossing 180 feet south of	35 02 44.7	87 32 14.5
Second-class road	35 02 03.4	87 32 39.5
Road crossing, north end of trestle over	35 01 50.2	87 33 25.4
Iron City, road crossing 0.75 mile northeast of; 40 feet south to cattle guard, 40 feet west to center of bridge	35 01 27.1	87 34 19.3
Iron City, 0.25 mile northeast of; on capstone of abutment at northwest corner of 3-span truss bridge over Shoal Creek; chisel mark, "L"	35 01 13.6	87 34 44.2

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Wales, 300 feet north of Louisville and Nashville station, in west end of culvert at switch point; aluminum tablet stamped "Prim. Trav. Sta. No. 1"	35 14 56.4	87 04 58.6
Wales, 1.25 miles west of; three corners at Little Dry Creek	35 14 53.6	87 06 36.2
Big Dry Creek, three corners 0.25 mile west of; 35 feet southeast to telephone pole, 30 feet west to gate	35 14 40.7	87 07 17.9
Lower Bordenham, forks of road 125 feet east of store	35 14 04.7	87 08 51.0
Bordenham, forks of road 100 feet west of post-office	35 13 56.5	87 08 31.9
Bordenham, forks of road at Choats Creek, 1.25 miles west of; 100 feet east to corner wire fence, 100 feet south to creek	35 13 26.8	87 10 30.4
Choats Creek Church, at southwest corner of; iron post stamped "Prim. Trav. Sta. No. 63"	35 13 30.5	87 11 14.2

Geographic positions along highways—Continued.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Forks of road, 75 feet east to creek, 40 feet north to sycamore tree	35 13 00.7	87 12 12.7
T road south, 5 feet southwest to small oak, 40 feet east to W. W. Bishop's mail box	35 13 07.0	87 13 33.0
Second-class road south	35 13 20.1	87 14 44.1
Forks of road, 15 feet southwest to oak tree, 30 feet northwest to double oak tree	35 13 36.9	87 16 11.5
Four corners, north and south and east and west, 50 feet northeast to fence corner, 45 feet southeast to fence corner	35 13 57.0	87 17 01.2
Four corners at mill	35 14 09.6	87 18 24.9
Lawrenceburg, three corners at east edge of; 20 feet north to corner yard fence, 35 feet east to elm tree	35 14 17.5	87 19 39.4
Lawrenceburg, crossing of Pulaski street and Louisville and Nashville Railroad	35 14 21.5	87 20 04.4
Lawrenceburg, in north wall east of entrance to courthouse, aluminum tablet stamped "Prim. Trav. Sta. No. 166"	35 14 22.6	87 20 07.7
Shoal Creek, center of pier of iron bridge over	35 14 26.3	87 21 15.1
Lawrenceburg, forks of road 2.25 miles west of; 60 feet southeast to persimmon tree; 40 feet north to wire fence.	35 14 38.1	87 21 57.2
Lawrenceburg, forks of road, 2.75 miles west of; 20 feet south to old stump; 40 feet southwest to oak tree	35 14 26.6	87 22 35.5
Lawrenceburg, forks of road 4 miles west of; 25 feet south to small oak; 35 feet west to oak tree	35 14 14.8	87 23 32.2
Four corners, 60 feet north to oak tree; 60 feet west to oak tree	35 14 07.6	87 24 26.7
Schoolhouse, second-class road to southwest; 500 feet west of	35 13 44.6	87 25 24.2
Yellow house, forks of road	35 13 30.8	87 26 14.0
Venus, four corners 1 mile east of; 10 feet west to corner rail fence; 50 feet south to oak tree	35 13 36.8	87 27 09.0
Venus, forks of road 0.3 mile southeast of; 250 feet southeast of schoolhouse	35 12 51.1	87 27 57.5
Venus, forks of road at ford of Knob Creek, 1 mile west of.	35 12 37.8	87 28 52.1
Second-class road to west	35 12 51.5	87 29 50.4
Four corners, 20 feet south to oak tree; 40 feet northwest to oak tree	35 12 58.8	87 30 43.3
Forks of road northwest and southwest at branch	35 12 52.6	87 32 00.7

MINNESOTA-WISCONSIN.

TRIANGULATION STATIONS.

HOUSTON AND WINONA COUNTIES, MINN.; LA CROSSE AND MONROE COUNTIES, WIS.

LA CROSSE AND SPARTA QUADRANGLES.

In the summer of 1905 Mr. S. S. Gannett, geographer, extended triangulation eastward from Dresbach and McDonald stations, of the Mississippi River Commission, situated on the river bluffs west of La Crosse, Wis., for the control of the La Crosse and Sparta 15-minute quadrangles. Six stations were occupied and 2 points were located by intersections.

Positions are given on the Cairo, Ill., astronomic datum as published in the report of the Chief of Engineers, United States Army, 1895, part 6, pages 3736–3741.

DRESBACH, WINONA COUNTY, MINN.

A station of the Mississippi River Commission on a flat ridge 1 mile below Dresbach, Minn., and 4 miles north of La Crescent, on edge of road at northeast corner of yard in front of residence of Michael Ready.

Station mark: An iron post set 3 feet in the ground.

Reference marks: Windmill in barnyard of Mr. Ready, true azimuth, 83° 01′; distant 142.3 feet.

[Latitude 43° 52′ 33.93″. Longitude 91° 20′ 18.12″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wedeking	243 52 07.2	63 58 42.8	4.15149
Kinney	261 23 45.8	81 31 13.1	4.16331
St. Joseph	292 03 23.3	112 15 56.3	4.41884
McDonald	343 46 39.0	163 48 37.7	4.13774

MCDONALD, HOUSTON COUNTY, MINN.

A station of the Mississippi River Commission in sec. 2, T. 103 N., R. 4 W., on property of Mr. Michael McDonald, 6 miles below La Crescent, Minn. Station is at northeast corner of barnyard, 194 feet northeast of northeast corner of stone house, but is not on highest point of ridge, which is 100 yards west and 10 feet higher.

Station mark: An iron post set 3½ feet in the ground, stamped "Latitude 43° 45′ 27″; longitude 91° 17′ 27″."

Reference marks: East chimney on house, true azimuth, 49° 09′; distance, 212.9 feet.

[Latitude 43° 45′ 26.67″. Longitude 91° 17′ 26.64″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Dresbach	163 48 37.7	343 46 39.0	4.13774
Wedeking	204 37 06.3	24 41 42.7	4.32970
St. Joseph	260 46 58.2	80 57 31.8	4.31694

BALLS BLUFF, MONROE COUNTY, WIS.

Station is on northern end of a level ridge, timbered on eastern edge of summit and nearly cleared on western slope, in sec. 8, T. 16 N., R. 3 W., 5 miles southeast of Sparta. To reach it, drive south from Sparta to house of D. Peters, thence by old road through fields to foot of bluff.

Station mark: Black oak signal tree blazed on three sides, with white target nailed on.

Reference marks: Black oak tree N. 30° E., 27 feet distant; oak tree N. 80° E., 33 feet distant; oak tree S. 10° W., 21 feet distant.

[Latitude 43° 52′ 58.38″. Longitude 90° 46′ 11.14″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Norwegian Lutheran Church	51 59 49.2	231 55 12.4	4.05424
Kinney	92 42 47.4	272 26 35.6	4.49583
Wedeking			4.52370
Castlerock	147 14 30.5	327 10 36.5	4.14276

CASTLE ROCK, MONROE COUNTY, WIS.

A well-known rocky butte 4 miles northwest of Sparta, in south-central part of sec. 33, T. 18 N., R. 4 W.

Signal: A sapling, brush top, white flag, and targets.

Station mark: A bronze triangulation tablet cemented in out-cropping sandstone ledge on highest point.

[Latitude 43° 59′ 16.77″. Longitude 90° 51′ 48.45″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Norwegian Lutheran Church	4 15 39.8	184 14 56.7	4.27213
St. Joseph	31 56 52.9	211 49 41.5	4.41990
Kinney	66 42 32.9	246 30 14.3	4.41271
Balls Bluff	327 10 36.5	147 14 30.5	4.14276

KINNEY, LA CROSSE COUNTY, WIS.

In N.W. ¼ N.E.¼ sec. 1, T. 16 N., R. 7 W., 5 miles west of West Salem and 9 miles northeast of La Crosse.

The summit of the knob is heavily timbered and the station is on cleared part of ridge 200 feet south of summit and 60 feet south of a stone quarry, and is 20 feet lower than highest point of knob.

Signal: A trimmed hickory sapling, white flag, and targets.

Station mark: A stone post 8 by 10 by 20 inches, set 18 inches in the ground; in center of top of post is cemented a bronze triangulation tablet.

[Latitude 43° 53′ 44.03″. Longitude 91° 09′ 32.88″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Dresbach	81 31 13.1	261 23 45.8	4.16331
Wedeking			3.64300
Castle Rock	246 30 14.3	66 42 32.9	4.41271
Balls Bluff	272 26 35.6	92 42 47.4	4.49583
St. Joseph	320 38 21.9	140 43 28.1	4.19276

NORWEGIAN LUTHERAN CHURCH, MONROE COUNTY, WIS.

(Not occupied.)

A brick church with tall spire, in center of sec. 32, T. 16 N., R. 4 W., Leon Township, about 6 miles south-southwest of Leon village.

Station mark: Center of spire.

[Latitude 43° 49′ 12.16″. Longitude 90° 52′ 50.65″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wedeking			4.43262
Castle Rock	184 14 56.7	4 15 39.8	4.27213
Balls Bluff	231 55 12.4	51 59 49.2	4.05424

ST. JOSEPH CHURCH, LA CROSSE COUNTY, WIS.

(Not occupied.)

A prominently located church on St. Joseph Ridge T. 15 N., R. 6 W. Station mark: Center of church spire.

[Latitude 43° 47′ 13.32″. Longitude 91° 02′ 10.77″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
McDonald	80 57 31.8	260 46 58.2	4.31694
Dresbach	112 15 56.3	292 03 23.3	4.41884
Kinney	140 43 28.1	320 38 21.9	4.19276
Wedeking			4.29735
Castle Rock	211 49 41.5	31 56 52.9	4.41990

WEDEKING, LA CROSSE COUNTY, WIS.

On a flat, cleared ridge, 4 miles northeast of Onalaska, in sec. 23, T. 17 N., R. 7 W., owned by Henry Wedeking, who lives 100 yards northeast of station.

Signal: A trimmed sapling with white targets.

Station mark: A dressed stone post 42 by 6 by 6 inches set 40 inches in the ground, in center of top of which is cemented a bronze triangulation tablet.

[Latitude 43° 55′ 55.80″. Longitude 91° 10′ 47.63″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
McDonald	24 41 42.7	204 37 06.3	4.32970
Dresbach	63 58 42.8	243 52 07.2	4.15149
Balls Bluff			4.52370
St. Joseph			4.29735
Kinney			3.64300

WISCONSIN.

PRIMARY TRAVERSE.

DODGE, KENOSHA, MILWAUKEE, RACINE, ROCK, WALWORTH, AND WAUKESHA COUNTIES.

CLYMAN, DELAVAN, EAGLE, GENEVA, KOSHKONONG, MILWAUKEE, OCONOMOWOC, RACINE, WATERTOWN, AND WHITEWATER QUADRANGLES.

The following geographic positions in southeastern Wisconsin were determined from primary traverse by Mr. George T. Hawkins, topographer, in 1904. The line starts at Benton triangulation station of the

United States Lake Survey, runs westward along or near Illinois-Wisconsin State line to longitude 88° 30′; thence northward along the eastern border of the Delavan quadrangle to latitude 42° 45′; thence westward along the northern border of the Delavan and Shopiere quadrangles to Janesville triangulation station of the United States Coast and Geodetic Survey, which, however, could not be identified. The line was also run around the Whitewater quadrangle, with a spur to Oakland triangulation station, and extended northward, connecting with Lebanon triangulation station and Clyman primary traverse station. Another line was extended eastward from Dousman along the Chicago and Northwestern Railway, and was connected with Delafield triangulation station and Milwaukee court-house spire triangulation station, United States Lake Survey. Positions are given on the United States standard datum.

DODGE COUNTY, CLYMAN QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Ashippun, T road west, 2 miles north of	43 15 15.3	88 31 49.0
"Neosho 3.5 mi.; Ashippun 3 miles; Oconomowoc 11 mi." (signboard), 35 feet northwest of, on east side of north and south road, on land owned by Albert Windroff, iron post stamped "Prim. Trav. No. 16, 1904"	43 16 07.5	88 31 54.9
T road north, 0.5 mile west of bench mark No. 16	43 16 08.8	88 33 05.8
Lebanon triangulation station (United States Coast and Geodetic Survey)	43 16 35.2	88 35 33.7
T road north, 1 mile west of Lebanon triangulation station	43 16 39.5	88 36 46.0
Schoolhouse No. 5, three corners	43 17 03.8	88 37 40.5
Silver Cheese Factory, road north	43 16 57.2	88 39 19.8
Clyman, 3 miles southeast of, 2 miles east of Chicago and Northwestern Railway, 400 feet northwest of John Clayton's house, 500 feet southwest of Christ Eiffert's house, on top of hill, south side of road, iron post stamped "Prim. Trav. No. 17, 1904"	43 17 04.8	88 40 55.5
Union Cheese Factory, crossroads	43 17 05.4	88 42 19.4
Clyman, railway crossing 0.25 mile north of	43 18 50.4	88 43 07.7
Clyman, 0.25 mile north of, 37 feet east of railway, 120 feet north of center of east and west road, iron post stamped "Prim. Trav. No. 18, 1904"	43 18 50.5	88 43 07.3

WALWORTH COUNTY, DELAVAN QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Geneva, T road south, 4 miles west of	42 34 59.0	88 31 08.3
Yerkes Observatory (geodetic), from primary traverse	42 34 15.8	88 33 24.4
Yerkes Observatory (astronomic)	42 34 12.6	88 33 18.6
Williams Bay, junction of roads 1.5 miles north of	42 36 00.8	88 32 26.4
Geneva triangulation station, United States Coast and Geodetic Survey	42 37 05.4	88 32 12.9
T. 2 N., Rs. 16 and 17 E., secs. 19 and 24, quarter corner between	42 37 09.4	88 32 26.4
T. 2 N., Rs. 16 and 17 E., secs. 13 and 18	42 38 01.4	88 32 27.2
T. 2 N., Rs. 16 and 17 E., 130 feet southeast of corner of secs. 7, 18, 13, and 12, 2 miles south of Elkhorn, on east side of road in front of Loren Baker's house, iron post stamped "Prim. Trav. Sta. No. 5, 1904"	42 38 26.2	88 32 27.3
T. 2 N., Rs. 16 and 17 E., corner of secs. 7, 18, 13, and 12.	42 38 27.5	88 32 27.5
Elkhorn, crossing Park and East streets	42 40 13.6	88 32 27.5
T. 3 N., Rs. 16 and 17 E., quarter corner between secs. 19 and 24	42 42 22.5	88 32 30.5
Elkhorn, T road south, 3.75 miles north of	42 43 32.2	88 32 33.2
Mayview, 2.5 miles west of; on north side of east and west road at T road, 12 feet northeast of mail box marked "E. H. Brownson," iron post stamped "Prim. Trav. Sta. No. 6, 1904"	42 44 55.0	88 32 01.9
J. E. Parsons's house, three corners	42 43 54.8	88 34 19.5
Tibbetts's house, three corners	42 44 04.1	88 34 55.0
Millard, T. 3 N., R. 16 E., secs. 8 and 9, quarter corner between	42 44 04.0	88 37 16.0
Millard, 0.5 mile west of; at northeast corner of schoolhouse yard, district No. 4, 12 feet north and west of corner of iron fence, iron post stamped "Prim. Trav. Sta. No. 7, 1904"	42 44 03.5	88 37 52.4
Millard, T road south, 2 miles west of	42 44 14.3	88 40 15.4
T. 3 N., R. 15 E., at quarter corner between secs. 5 and 8, 70 feet southwest of schoolhouse, district No. 5, at southwest corner of school yard, 6.5 miles south of Whitewater, 35 feet northeast of crossroad, iron post stamped "Prim. Trav. Sta. No. 8, 1904"	42 44 24.7	88 44 58.1

JEFFERSON AND WALWORTH COUNTIES, KOSHKONONG QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Whitewater, crossroads 5.5 miles south of	42 45 18.4	88 45 00.2
Whitewater, crossroads 3 miles south of (creamery 400 feet west)	42 47 29.4	88 44 48.7
Whitewater, Congregational Church spire (Hawkins)	42 50 02.6	88 44 11.9
Whitewater, Congregational Church spire (United States States Coast Survey)	42 50 02.6	88 44 09.5
Whitewater Normal School, T street south, in front of	42 50 05.8	88 44 37.0
Whitewater Normal School, central dome (Hawkins)	42 50 09.9	88 44 37.2
Whitewater Normal School, central dome (United States Coast Survey)	42 50 10.9	88 44 37.3
Whitewater, junction of roads 1.5 miles northwest of	42 51 26.0	88 45 24.0
Whitewater, 4 miles northwest of; 0.33 mile southeast of Auman's house, 180 feet from telephone pole, marked "U. S. 794;" on east side of road, iron post stamped "Prim. Trav. Sta. No. 10, 1904"	42 52 28.1	88 46 13.2
Cold Spring, four corners at store	42 53 28.3	88 46 26.2
Cold Spring, T road west, 1 mile north of	42 54 15.8	88 46 39.4
Bridge over creek west, T road east, 400 feet north of	42 55 03.0	88 46 44.0
Fort Atkinson, T road west, 2 miles east of	42 55 22.3	88 46 46.3
Bridge, elevation marked "U. S. 803.806"	42 56 48.4	88 46 51.4
Schoolhouse No. 10, road in front of	42 58 57.5	88 46 37.5
T. 6 N., Rs 14 and 15 E., corner secs. 7, 12, 13, and 18	42 59 24.0	88 46 37.9
Jefferson, 1 mile east of; T. 6 N., Rs. 14 and 15 E., 30 feet southeast of corner of secs. 1, 6, 7, and 12; iron post stamped "Prim. Trav. Sta. No. 11, 1904"	43 00 16.5	88 46 57.2
Jefferson, Catholic Church spire 1 mile east of (Hawkins)	43 00 17.9	88 46 44.4
Jefferson, Catholic Church spire 1 mile east of (Coast and Geodetic Survey)	43 00 17.9	88 46 45.1
Jefferson, German Methodist Episcopal Church spire	43 00 19.7	88 48 19.7
Jefferson, German Methodist Episcopal Church spire (Coast and Geodetic Survey)	43 00 24.7	88 48 09.6
Jefferson, Catholic Church spire	43 00 24.6	88 48 09.7
T. 6 N., R. 14 E., quarter corner between secs. 4 and 9	43 00 24.8	88 50 48.6
T. 6 N., Rs. 13 and 14 E., corner secs. 1, 6, 7, 12	43 00 27.8	88 53 39.2
Oakland triangulation station (Coast and Geodetic Survey)	42 59 11.98	88 53 49.06

KENOSHA AND WALWORTH COUNTIES, GENEVA QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Twin Lakes, 0.75 mile west of; 550 feet west of elbow in road, 400 feet north of Mr. Oelson's barn, iron post stamped "Prim. Trav. Sta. No. 3, 1904"	42 31 52.2	88 16 06.6
J. F. Reynold's house, T road south, 0.25 mile north of	42 31 26.3	88 17 19.6
T. 1 N., R. 18 E., quarter corner between secs. 25 and 26	42 30 59.6	88 19 27.8
Genoa Junction, crossing Chicago and Northwestern Railway 2 miles northwest of	42 31 13.2	88 20 54.9
T. 1 N., R. 18 E., corner secs. 21, 22, 27, and 28	42 31 25.2	88 21 49.2
T. 1 N., R. 18 E., quarter corner between secs. 20 and 29	42 31 25.6	88 23 34.6
T. 1 N., Rs. 17 and 18 E., quarter corner between secs. 30 and 25	42 30 59.3	88 25 21.7
T. 1 N., R. 17 E., 30 feet northeast of quarter corner between secs. 25 and 26, at southwest corner of Bloom Prairie Farm, owned by J. G. Nichols, iron post stamped "Prim. Trav. Sta. No. 4, 1904"	42 30 59.7	88 26 33.1
T. 1 N., R. 17 E., corner of secs. 13, 14, 23, and 24	42 32 44.5	88 26 33.9
Geneva, junction of roads, 2 miles southwest of	42 33 28.0	88 26 34.0
Geneva, crossing Main and Broad streets	42 35 30.6	88 26 06.0
Geneva, crossroads 2.5 miles west of	42 35 10.8	88 28 55.6

MILWAUKEE COUNTY, MILWAUKEE QUADRANGLE.

Geographic positions along the Chicago and Northwestern Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
North Greenfield, railway crossing, 1.25 miles east of	43 00 27.8	87 59 19.5
Overhead crossing, 200 feet west of	43 00 11.3	87 58 30.2
Layton Park, crossing west of station	42 59 45.6	87 57 13.9
Catholic Cathedral, railway crossing 3 blocks south of	42 59 41.8	87 55 07.4
Milwaukee court-house dome (United States Lake Survey station)	43 02 31.9	87 54 17.6

DODGE AND WAUKESHA COUNTIES, OCONOMOWOC QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Dousman, crossroads 3.25 miles northwest of	43 02 51.0	88 29 10.8
T. 7 N., R. 17 E., corner of secs. 15, 16, 21, and 22	43 03 44.4	88 28 52.6
T. 7 N., R. 17 E., corner of secs. 15, 16, 9, and 10	43 04 36.6	88 28 50.7
Oconomowoc, crossing Main and West avenues	43 06 41.4	88 29 57.5
Oconomowoc, 2 miles north of, in front of A. Cottrell's house on east side of north and south road; iron post stamped "Prim. Trav. Sta. No. 15, 1904"	43 08 16.9	88 29 58.2
T. 8 N., R. 17 E., quarter corner between secs. 20 and 21	43 08 35.8	88 29 58.3
T. 8 N., R. 17 E., corner of secs. 16, 17, 20, and 21	43 09 01.9	88 29 58.3
Monterey, crossroads ½ mile north of; T. 8 N., R. 17 E., corner of secs. 4, 5, 8, and 9	43 10 46.6	88 30 00.3
Monterey, crossroads 1.75 miles northwest of	43 11 44.8	88 30 25.4
Ashippun, crossroads 1.25 miles southeast of	43 12 36.9	88 30 54.7
Ashippun, crossroads	43 13 29.4	88 31 10.8

Geographic positions along the Chicago and Northwestern Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Dousman, railway crossing	43 00 50.3	88 28 21.6
Dousman, railway crossing 1.25 miles east of	43 00 56.0	88 26 46.4
Delafield triangulation station (United States Coast Survey)	43 01 57.0	88 23 33.3

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Wales, crossroads 0.75 mile northwest of	43 00 43.2	88 23 01.4
Wales, 0.75 mile northwest of; 750 feet east of crossroads, on south side of road; iron post stamped "Prim. Trav. Sta. No. 19, 1904"	43 00 45.7	88 22 51.8
Stone schoolhouse, road south	43 01 14.3	88 20 37.3
Stone schoolhouse, three corners 1 mile east of	43 01 13.5	88 19 27.6
Waukesha, crossroads 2.5 miles west of	43 00 47.8	88 17 09.0

KENOSHA COUNTY, RACINE QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Benton triangulation station, United States Lake Survey..	42 29 02.88	87 52 43.35
Benton, crossroads on Illinois-Wisconsin State line, 0.75 mile northwest of	42 29 37.4	87 53 12.0
Illinois-Wisconsin State line, T road west 0.25 mile south of.	42 29 25.5	87 54 09.1
Illinois-Wisconsin State line, T road west 0.5 mile north of.	42 30 04.9	87 54 42.9
Illinois-Wisconsin State line, Elbow road north and west on.	42 29 40.9	87 57 03.4
Illinois-Wisconsin State line, crossroads on	42 29 41.5	87 58 17.4
T. 1 N., R. 21 E., 50 feet northeast of south corner secs. 34 and 35, on north side of State line road, about 800 feet northwest of Charles Crawford's house; iron post stamped "Prim. Trav. Sta. No. 1 1904"	42 29 42.5	87 59 24.5

ROCK AND WALWORTH COUNTIES, SHOPIERE QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 3 N., Rs. 14 and 15 E., corner secs. 1, 6, 7, and 12	42 44 24.1	88 46 41.8
T. 3 N., R. 14 E., quarter corner between secs. 2 and 11..	42 44 23.8	88 48 27.2
Johnson Center, crossroads 3 miles north of and 0.75 mile east of	42 44 14.1	88 49 38.6
Johnson Center, crossroads 3 miles north of	42 44 20.2	88 50 31.8
Brick schoolhouse, crossroads	42 44 27.3	88 51 25.1
"Milton, 4 miles" from, 920 feet west of crossroads where signpost is, on north side of road; iron post stamped "Prim. Trav. Sta. No. 9, 1904"	42 44 30.9	88 52 48.3
T. 3 N., Rs. 13 and 14 E., corner secs. 1, 6, 7, and 12	42 44 32.1	88 53 43.2
T. 3 N., R. 13 E., corner secs. 1, 2, 11, and 12	42 44 33.2	88 54 54.7
T. 3 N., R. 13 E., corner secs. 12, 11, 13, and 14	42 43 41.4	88 54 54.0
T. 3 N., R. 13 E., corner secs. 10, 11, 14, and 15	42 43 42.6	88 56 03.8
T. 3 N., R. 13 E., corner secs. 9, 10, 15, and 16	42 43 42.9	88 57 15.2
Janesville, crossroads 2.75 miles northeast of (roads run northeast and southwest and northwest and southeast).	42 43 12.2	88 59 47.6
County Farm, crossroads at northwest corner of	42 43 48.8	89 01 57.5
Brick schoolhouse, crossroads	42 43 48.8	89 02 33.7
Rock River, T road south 0.25 mile west of	42 43 48.2	89 03 49.8

KENOSHA COUNTY, SILVER LAKE QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Pikeville, crossroads	42 29 44.8	88 01 30.0
Hosmer Church, junction of roads	42 30 35.8	88 01 46.5
Antioch, T road west, 2 miles northeast of	42 30 11.4	88 04 43.7
Antioch, 2 miles north of, crossroad	42 30 23.9	88 05 46.2
T. 1 N., R. 20 E., corner secs. 27, 28, 33, and 34	42 30 37.2	88 07 40.9
Trevor, 1 mile west of, on south side of road in front of George Faulkner's house, iron post stamped "Prim. Trav. Sta. No. 2, 1904"	42 30 36.8	88 08 17.3
Wilmot, intersection of streets at hotel	42 30 46.6	88 10 53.4
T. 1 N., R. 19 E., secs. 26 and 35, quarter corner between.	42 30 35.2	88 12 58.8
T road west	42 31 53.2	88 13 00.9
Twin Lakes, T road east, 0.5 mile east of	42 31 52.4	88 14 52.8
Twin Lakes, road in front of railway station	42 31 52.6	88 15 12.4

WAUKESHA COUNTY, WAUKESHA QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Waukesha, at southwest corner of Madison and Washington streets, iron post stamped "Prim. Trav. Sta. No. 20, 1904"	43 00 48.3	88 14 43.4

Geographic positions along the Chicago and Northwestern Railway.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Waukesha, crossing Wisconsin Central Railway and Chicago and Northwestern Railway	43 00 19.8	88 13 53.0
Springdale, railway crossing	43 00 35.2	88 11 10.5
Calhoun, 275 feet southwest of railroad station, on south side of railway, 30 feet west of north and south road, iron post stamped "Prim. Trav. Sta. No. 21, 1904"	43 00 35.7	88 07 37.3
Edgemore, north and south road crossing	43 00 36.1	88 06 26.6
Sunny Slope, north and south road crossing	43 00 36.3	88 05 14.7
County line, north and south road crossing	43 00 36.5	88 04 01.9
North Greenfield, overhead road crossing 0.75 mile west of.	43 00 36.8	88 01 36.5
North Greenfield, 150 feet southeast of station, 25 feet south of railway and 50 feet southwest of end of double track, iron post stamped "Prim. Trav. Sta. No. 22, 1904"	43 00 36.7	88 00 47.6

JEFFERSON, WALWORTH, AND WAUKESHA COUNTIES, WHITEWATER QUADRANGLE.

Geographic positions along highways.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Jefferson, junction of roads at church 2 miles east of	43 00 39.9	88 45 50.5
Jefferson, T road north, 3.5 miles east of	43 01 01.2	88 44 21.8
Jefferson, T road north, 4.5 miles east of	43 01 07.8	88 43 10.8
Helensville, flag pole on schoolhouse	43 00 43.7	88 41 55.4
Helensville, crossroads 1 mile east of	43 00 51.5	88 40 45.9

Geographic positions along the Chicago and Northwestern Railway between Helensville and Dousman.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Helensville, railway crossing 1.5 miles east of	43 00 47.2	88 40 04.4
Helensville, railway crossing 2.5 miles east of	43 00 40.0	88 38 43.4
Helensville, railway crossing 4 miles east of	43 00 43.8	88 37 24.6
Sullivan, on north side of railway right of way, 200 feet west of station, iron post stamped "Prim. Trav. Sta. No. 12, 1904"	43 00 42.5	88 35 20.6
Sullivan, overhead railway crossing 1.5 miles east of	43 00 41.9	88 33 39.2
Flag station, railway crossing	43 00 38.9	88 32 49.1
Dousman, railway crossing 0.5 mile west of	43 00 48.7	88 28 58.1

JEFFERSON, WALWORTH, AND WAUKESHA COUNTIES, WHITEWATER QUADRANGLE—cont'd.

Geographic positions along highways.

Station.	Latitude.	Longitude.
Dousman, 0.75 mile southwest of, at T road north, on south side of road, 8 feet north of east and west fence, 250 feet southwest of Jake Stevens's house, iron post stamped "Prim. Trav. Sta. No. 13, 1904"	° ′ ″ 43 00 38.2	° ′ ″ 88 28 58.1
Dousman, junction of roads 1.5 miles southwest of	43 00 09.3	88 29 52.9
Catholic Church, road in front of	42 59 36.1	88 30 39.7
Junction of road south with road northeast and southwest	42 58 48.6	88 31 57.2
T. 6 N., R. 17 E., sec. 19, center of	42 58 02.5	88 31 57.3
T. 6 N., R. 17 E., secs. 19 and 30, quarter corner between	42 57 36.2	88 31 57.6
T. 6 N., R. 17 E., corner secs. 19, 24, 25, and 30	42 57 36.7	88 32 30.2
Siloam Chapel, crossroads	42 55 37.6	88 32 30.9
Creamery, crossing north and south road with northeast and southwest road	42 54 18.2	88 32 31.0
Palmyra, 3 miles east of, 20 feet south of three corners, 6 feet north of railway fence, 160 feet east of railway crossing, iron post stamped "Prim. Trav. Sta. No. 14, 1904"	42 52 45.2	88 32 30.7
T. 5 N., Rs. 16 and 17 E., quarter corner between secs. 31 and 36	42 51 08.5	88 32 29.3
Schoolhouse and creamery, crossroads	42 48 01.2	88 31 59.0
Three corners, road south	42 47 36.4	88 31 42.9
Elbow in road, north and west	42 46 43.6	88 31 45.1
T. 4 N., Rs. 16 and 17 E., quarter corner between secs. 25 and 30	42 46 42.8	88 32 36.6
T. 4 N., Rs. 16 and 17 E., quarter corner between secs. 31 and 36	42 45 51.1	88 32 37.3

WESTERN DIVISION OF TOPOGRAPHY.

E. M. Douglas, *Geographer in charge.*

ARIZONA.

SECONDARY TRIANGULATION STATIONS.

MARICOPA COUNTY.

CAMELS BACK, DESERT WELL, AND FORT M'DOWELL QUADRANGLES.

In the winter of 1904–5 Mr. T. M. Bannon, topographer, occupied a number of three-point and secondary triangulation stations in order to obtain additional control for three 15-minute quadrangles in Maricopa County.

Positions are based upon Santan, Walker, Superstition, and Four Peaks; Maricopa astronomic datum.

BUCHANANS TANK, MARICOPA COUNTY.

(Not occupied.)

The galvanized water tank on the platform 10 feet south of the Desert Well. Twelve miles east of mesa on telephone road to Florence.

Station mark: Center of tank.

[Latitude 33° 20′ 56.90″. Longitude 111° 36′ 38.96″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Number Four	....	....	3.9339890
Usery	....	....	4.2272149

CORRECTION CORNER, MARICOPA AND PINAL COUNTIES.

Correction corner on the base line between Tps. 1 N. and 1 S. and Rs. 7 and 8 E. of the Gila and Salt rivers meridian. This corner also marks an angle between Maricopa and Pinal counties. The station was located by the three-point method.

[Latitude 33° 22′ 39.19″. Longitude 111° 35′ 02.33″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Walker	....	....	4.5491195
Santan	....	....	4.4082288

DOME HILL, MARICOPA COUNTY.

(Not occupied.)

Bush on center of high dome-shaped hill several miles northwest of Goldfield.

Station mark: Center of bush.

[Latitude 33° 30′ 04.53″. Longitude 111° 32′ 43.67″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Texas			4.2121371
Usery			3.9490697

EASTEND, MARICOPA COUNTY.

(Not occupied.)

Station mark: Highest point of a big bowlder hill on the northeast end of the McDowell Mountains.

[Latitude 33° 40′ 42.50″. Longitude 111° 48′ 02.95″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Lousley			3.9819277
Fraesfield			3.9040694

FORT M'DOWELL, MARICOPA COUNTY.

(Not occupied.)

Station mark: Center of the agent's house at old Fort McDowell.

[Latitude 33° 38′ 07.72″. Longitude 111° 40′ 38.56″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Texas			3.9024770
Usery			4.1900818

FRAESFIELD, MARICOPA COUNTY.

On a lone hill near the divide between the Verdi River and Paradise Valley, about 14 miles northwest of old Fort McDowell.

Station mark: A bronze tablet cemented into solid rock under a large rock monument.

[Latitude 33° 45′ 01.18″. Longitude 111° 48′ 36.05″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Lousley	297 03 54.93	117 07 30.75	4.0507955
Usery	330 35 46.43	150 41 23.08	4.5046607

LOUSLEY, MARICOPA COUNTY.

On the highest point north of the low hills on the west side of the Verdi River and about 4 miles north of old Fort McDowell.

Station mark: A tablet cemented in a large bowlder centered under a large rock monument.

[Latitude 33° 42′ 14.99″. Longitude 111° 42′ 07.35″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Texas			4.0889721
Usery	346 01 21.75	166 03 23.08	4.3697898

NUMBER THREE, MARICOPA COUNTY.

A three-point station on a small isolated knob on the north side of the Mesa-Goldfield road, 17 miles east of Mesa and 5 miles west of Goldfield.

Station mark: A bronze tablet cemented into solid rock under a small rock monument.

[Latitude 33° 26′ 14.96″. Longitude 111° 38′ 27.80″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Number Four			3.6116108
Usery			3.8349543

NUMBER FOUR, MARICOPA COUNTY.

(Not occupied.)

On a lone malpais hill 12 miles northeast of Mesa, 2 miles northwest of the crossing of Usery Pass—Desert Well and the Mesa—Goldfield roads.

Station mark: A bronze tablet centered under a small rock monument.

[Latitude 33° 25′ 33.53″. Longitude 111° 35′ 57.41″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Usery	154 23 30.16	334 22 07.08	3.9541864
Superstition	275 32 03.54	95 38 36.05	4.2672195

NUMBER FIVE, MARICOPA COUNTY.

(Not occupied.)

Highest point of the rock bluff on the east side of Usery Pass.

Station mark: A 2 by 4 scantling driven between two rocks.

[Latitude 33° 29′ 04.56″. Longitude 111° 35′ 51.70″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Texas			4.2449715
Usery			3.6382264

ROCK PINNACLE, MARICOPA COUNTY.

(Not occupied.)

Station mark: Center of a rock pinnacle about 3 miles west of the divide between Paradise Valley and Verdi River.

[Latitude 33° 43′ 34.40″. Longitude 111° 51′ 54.29″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Lousley			4.1849621
Fraesfield			3.7604678

STEWARTS, MARICOPA COUNTY.

On the southwestern of three granite mountains on the north side of Salt River 4 miles east of its junction with the Verdi.

Station mark: A cross (+) chiseled on solid rock under a large rock monument.

[Latitude 33° 34′ 51.50″. Longitude 111° 33′ 31.00″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Texas			3.8771431
Usery			4.074019

SUGARLOAF, MARICOPA COUNTY.

(Not occupied.)

On the highest point of a flat topped malpais hill, locally known as Sugarloaf, on the south side of Sycamore Creek and about 8 miles east of old Fort McDowell.

[Latitude 33° 41′ 43.50″. Longitude 111° 31′ 52.11″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Texas			3.9077180
Usery			4.3810111

TEXAS, MARICOPA COUNTY.

A 3-point station on the highest point of the center of three malpais hills on the south side of Sycamore, 6 miles east of old Fort McDowell.

Station mark: A bronze tablet cemented into solid rock under a large rock monument.

[Latitude 33° 38′ 34.82″. Longitude 111° 35′ 30.28″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Superstition			4.4961269
Usery	16 03 01.41	196 01 23.08	4.2201578

USERY, MARICOPA COUNTY.

A 3-point station on the highest point of the hills west of the Usery Pass, about 15 miles northeast of Mesa and 3½ miles south of the junction of the Verdi and Salt rivers.

Station mark: A bronze tablet cemented into a large bowlder over which was built a tripod.

[Latitude 33° 29′ 56.90″. Longitude 111° 38′ 28.08″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Superstition	293 54 32.08	114 02 28.05	4.3874513
Four Peaks	234 00 01.23	55 10 38.43	4.5520318

CALIFORNIA.

TRIANGULATION STATIONS.

SAN DIEGO COUNTY.

HOLTVILLE AND IMPERIAL QUADRANGLES.

In the spring of 1904 Mr. C. F. Urquhart, topographer, in cooperation with the Reclamation Service, extended a belt of triangulation westward from the vicinity of Yuma, Ariz., through San Diego County, connecting with stations Tecate and Cuyamaca, of the United States Coast and Geodetic Survey. In the prosecution of this work Mr. Urquhart occupied 25 stations for the control of an area of 2,500 square miles.

The positions given herewith are based upon Cuyamaca-Tecate on the United States standard datum.

AMERICAN, SAN DIEGO COUNTY.

On the highest point of a range of mountains lying east of the American gold mine and about 3 miles a little south of east from the mine. Take road from Yuma to the American gold mine. Horses can be taken within a mile of station by following wash from the mine.

Station mark: A bronze triangulation tablet cemented in rock and placed under center of cairn 8 feet high.

[[a] Latitude 32° 51′ 26.38″. Longitude 114° 45′ 09.10″.]
[[b] Latitude 32° 51′ 27.53″. Longitude 114° 45′ 08.18″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sandy	[b] 39 59 10.25	219 54 43.91	4.2995209
Blizzard	[b] 80 54 55.70	260 47 44.70	4.3208401
Hardy	[b] 94 20 50.67	274 10 09.72	4.4884104
Quartz	[a] 165 40 41.19	345 38 23.65	4.4231629
Clip	[a] 209 57 00.53	30 02 27.81	4.4945347
Ridge	[a] 256 13 38.72	76 19 48.46	4.2607025
Sugarloaf	[a] 286 14 08.73	106 22 49.75	4.4157937
Yuma, azimuth station	[a] 322 06 18.04	142 10 39.78	4.3116694
Pilot	[a] 357 44 03.76	177 44 15.19	4.1430949
Pilot	[b] 357 44 01.80	177 44 13.23	4.1430929

[a] *From Lake Tahoe, United States standard.* [b] From Cuyamaca-Tecate, United States standard.

BLIZZARD, SAN DIEGO COUNTY.

On a high point near the center of Sand Hills, about 8 miles a little south of west from Ogilby, a station on Southern Pacific Railroad 16 miles west of Yuma. It is impossible to describe this point very accurately, as the hills are very similar and change more or less with every sand storm.

Signal: A lumber tripod.

Station mark: A 2 by 3 stake set in sand under center of tripod. No bench mark was available when station was occupied, and it is impossible to preserve this point.

[Latitude 32° 49′ 39.53″. Longitude 114° 58′ 22.90″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Gravel	44 06 15.85	224 01 10.68	4.3244724
Hardy	119 13 29.38	299 09 59.81	4.0609667
American	260 47 44.70	80 54 55.70	4.3208401
Pilot Knob	296 23 37.86	116 30 59.56	4.3750165
Sandy	326 34 08.21	146 36 52.18	4.1558855

BRAWLEY, SAN DIEGO COUNTY.

On a low sand hill covered with mesquite brush, in the southeast corner of the town of Brawley.

Signal: A lumber tripod 12 feet high, with target extending 6 feet higher.

Station mark: A standard bench-mark post set 40 inches in the ground under center of signal. (Probably permanent.)

[Latitude 32° 58′ 26.47″. Longitude 115° 32′ 09.12″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Imperial	10 29 41.16	190 28 49.21	4.1350684
Lucky	66 12 44.58	246 06 12.43	4.3114329
Sunset	280 06 42.20	100 15 10.03	4.3915585
Holtville	323 45 28.93	143 50 23.35	4.3777290

CALEXICO, SAN DIEGO COUNTY.

(Not occupied.)

Station mark: Center of top of water tank in the town of Calexico.

[Latitude 32° 39′ 53.95″. Longitude 115° 29′ 54.51″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Signal Mountain	76 39 39.90	256 32 51.24	4.3074526
Lucky	139 28 11.20	319 20 27.80	4.5343827

CAMPO, SAN DIEGO COUNTY.

On a long ridge 6 or 7 miles north-northwest from Campo post-office. To reach station from Campo there is a road to Mr. Hill's ranch, a distance of 2 miles. From this ranch an old wagon road goes up ridge about west to summit. The road has been abandoned and can not be traveled over with wagon, but is a good pack trail.

Signal: A cairn about 8 feet high, built on a large flat rock. There is a large rock which is a little higher than signal, about 200 yards southwest.

Station mark: A triangulation tablet set in rock under center of cairn.

[Latitude 32° 37′ 29.95″. Longitude 116° 32′ 39.72″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Tecate	69 32 57.82	249 28 18.54	4.1592400
Cuyamaca	170 47 24.15	350 45 23.49	4.5582424
Laguna	209 29 00.83	29 33 41.04	4.4374836
Jacumba	257 08 16.09	77 20 35.08	4.5633149

COYOTE, SAN DIEGO COUNTY.

On the highest point in the Coyote Mountains, 8 miles southeast from Carrizo Creek spring and about the same distance northwest from Coyote well, the first water on road from Blue Lake to Campo. It is not a very high mountain, but is rough and rocky. It can probably be most easily reached from the Coyote well side.

Station mark: A triangulation tablet cemented in solid rock, under center of a cairn 9 feet high.

[Latitude 32° 49′ 31.01″. Longitude 116° 00′ 52.89″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Jacumba	44 45 14.49	224 40 23.63	4.2985400
Laguna	92 39 59.49	272 27 26.61	4.5581308
Whale	128 53 57.23	308 44 08.24	4.5578864
Eagle	184 12 52.70	4 13 18.83	4.2302702
Lucky	252 25 57.37	72 35 01.37	4.4366284
Signal Mountain	308 01 14.25	128 11 09.34	4.5614279

CUYAMACA, SAN DIEGO COUNTY.

A station of the United States Coast and Geodetic Survey located on the southern and highest peak of Cuyamaca Mountain, about 60 miles northeast of the city of San Diego. It is best reached from San Diego by taking the Cuyamaca, San Diego and Eastern Railroad to Lakeside, a distance of about 20 miles. From Lakeside a stage runs daily, except Sundays, to Cuyamaca, a distance of about 40 miles. The south peak of mountain is distant about 4 miles from Cuyamaca. There is an old wood road up to within about 1½ miles of summit, and a wagon could go still nearer the station with light loads. The point selected for the station is on the backbone of the large ledge which forms the highest part of the summit. It is not, however, on the highest part of the ledge, but about 10 feet south of the highest point.

Station mark: A copper bolt with a cross on the end, set in hole drilled in rock.

Reference marks: The north copper bolt is 7.72 feet distant from station. The northeast copper bolt is 7.04 feet distant from station. The south copper bolt is 6.27 feet distant from the station.

[Latitude 32° 56′ 48.64″. Longitude 116° 36′ 22.53″. United States standard.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Tecate	10 42 49.80	190 40 09.90	4.6176690
Soledad	79 04 41.88	258 43 39.38	4.7893855
Santiago	134 42 27.17	314 11 52.70	5.0826613
Whale	251 16 11.33	71 25 40.89	4.4573560
Laguna	301 34 46.62	121 41 29.06	4.3545285
Campo	350 45 23.49	170 47 24.15	4.5582424

EAGLE, SAN DIEGO COUNTY.

On a high, bald point in the high foothills on the north side of Carrizo Creek and about 10 miles northeast from the Carrizo Spring, a well-known point on the road between Julian and Yuma. The spring is about 44 miles from Julian and about 40 miles from Imperial. Horses can be ridden within 2 or 3 miles of point by going up a "wash" entering into Carrizo Creek about 3 miles below the spring. Creek does not flow more than 1 mile before it disappears in the sand. There is another flat summit about as high as point used 2 or 3 miles distant to the east.

Station mark: Triangulation tablet cemented in rock under center of cairn.

[Latitude 32° 58′ 41.14″. Longitude 116° 00′ 04.79″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Coyote	41 31 08.83	184 12 52.70	4.2302702
Jacumba	26 09 03.31	206 03 45.76	4.5391935
Laguna	67 47 01.06	247 34 00.49	4.6059486
Whale	101 04 11.80	280 53 55.40	4.4760237
Lucky	289 19 50.00	109 28 28.96	4.4197360
Signal Mountain	325 07 59.34	145 17 29.60	4.6812910

GRAVEL, SAN DIEGO COUNTY.

On the United States and Mexico boundary, 4,068 feet from monument No. 214. Theodolite elevated 25 feet.

Station mark: A standard bench-mark post set 40 inches in the ground under center of tripod and platform. (The ground is solid and mark should be permanent.)

[Latitude 32° 41′ 27.10″. Longitude 115° 07′ 46.86″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Mesquite	93 39 02.85	273 34 15.82	4.1306964
Hog	140 20 18.06	320 16 52.70	4.1896933
Hardy	192 31 41.28	12 33 17.48	4.3281747
Blizzard	224 01 10.68	44 06 15.85	4.3244724
Sandy	261 49 37.80	81 57 26.19	4.3580589

HARDY, SAN DIEGO COUNTY.

On a low sand hill on the south side of main sand ridge, about 17 or 18 miles a little south of east from Sunset Spring, and it can probably be most easily reached from that place. The ditch east from Holtville may be closer water. There is no road and either way is through sand. The sand hill on which the signal stands is constantly moving, and the standard bench-mark post, which was set in sand for station mark, may be covered up or blown out of the ground within a very short time.

Signal: A lumber tripod.

Station mark: A standard bench-mark post set in the ground.

[Latitude 32° 52′ 41.74″. Longitude 115° 04′ 49.21″.]

To station—	Azimuth.	Back azimuth.	Log. distance
	° ′ ″	° ′ ″	*Meters.*
Gravel	12 33 17.48	192 31 41.28	4.3281747
Hog	58 34 14.53	238 29 12.31	4.2302956
Holtville	73 14 59.65	253 05 04.40	4.4745810
Sunset	108 53 49.36	288 47 25.62	4.2877086
American	274 10 09.72	94 20 50.67	4.4884104
Blizzard	299 09 59.81	119 13 29.38	4.0609667

HOLTVILLE, SAN DIEGO COUNTY.

On a small sand hill about 15 feet above the general elevation of the ground, about one-half mile south from the town of Holtville and on the south side of the Alamo River.

Signal: A platform 20 feet high with target about 12 feet higher. Theodolite elevated 25 feet.

Station mark: A standard bench-mark post set 40 inches in the ground.

[Latitude 32° 48′ 01.37″. Longitude 115° 23′ 06.89″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sharp	0 49 13.95	180 49 09.89	4.1347675
Signal Mountain	57 04 29.68	236 53 59.98	4.5585846
Imperial	109 25 47.09	289 20 01.32	4.2451920
Brawley	143 50 23.35	323 45 28.93	4.3777290
Sunset	214 17 36.78	34 21 09.15	4.2563137
Hardy	253 05 04.40	73 14 59.65	4.4745810
Hog	270 55 06.03	90 59 58.74	4.1480281
Mesquite	317 07 26.77	137 11 04.44	4.1876380

HOG, SAN DIEGO COUNTY.

On a low, bald sand hill 9 miles east from Holtville and about 5 miles east from the most eastern ditch. There are several sand hills very much like this one within a radius of a mile, but this is probably the highest.

Station mark: A standard bench-mark post set 40 inches in the sand. (Summit of this hill will probably change from time to time.)

[Latitude 32° 47′ 53.73″. Longitude 115° 14′ 06.53″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Mesquite	18 00 17.91	197 59 03.27	4.0654886
Sharp	46 49 36.34	226 44 40.06	4.2916431
Holtville	90 59 58.74	270 55 06.03	4.1480281
Sunset	165 39 08.03	345 37 47.15	4.1938152
Hardy	238 29 12.31	58 34 14.53	4.2302956
Gravel	320 16 52.70	140 20 18.06	4.1896933

HOGUE, SAN DIEGO COUNTY.

On a sand hill with mesquite brush on its side, situated about 8 miles a little east of north from Sunset Springs, and is the most western of a row of hills extending from station Sunset to this point, parallel with the main sand hills and south of them.

Signal: A lumber tripod 14 feet high, with target extending 6 feet higher.

Station mark: A standard bench-mark post set 40 inches in the sand (probably permanent).

[Latitude 33° 03′ 29.35″. Longitude 115° 19′ 26.11″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Holtville	11 21 45.21	191 19 45.19	4.4647396
Hardy	311 09 21.39	131 17 18.58	4.4811025
Sunset	342 03 37.74	162 05 10.61	4.1578776

IMPERIAL, SAN DIEGO COUNTY.

In the northwest corner of the town of Imperial on perfectly flat ground about 300 yards northeast of the large warehouse on west side of railroad and very near and south of the end of the "Y" on the railroad.

Signal: A platform 20 feet high, with target 12 feet higher.

Station mark: A standard bench-mark post set 40 inches in ground under center of target.

[Latitude 32° 51′ 10.83″. Longitude 115° 33′ 44.72″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Signal Mountain	28 17 27.61	208 12 42.40	4.4625328
Lucky	107 35 03.03	287 29 23.41	4.2319021
Brawley	190 28 49.21	10 29 41.16	4.1350684
Sunset	251 12 04.37	71 21 22.95	4.4509094
Holtville	289 20 01.32	109 25 47.09	4.2451920

JACUMBA, SAN DIEGO COUNTY.

On the highest point of a high, rocky ridge about 7 miles north-northeast from Jacumba, a ranch and store owned by Mr. W. P. Foster on the road from Campo to Imperial. The mountain is on the east side of Jacumba Creek and about east from Teele Mountain, another high point on west side of same creek. From Jacumba horses can be ridden to foot of mountain, and there is a good trail about two-thirds of the distance.

Station mark: A triangulation tablet cemented in solid rock under center of a cairn 8 feet high.

[Latitude 32° 41′ 52.27″. Longitude 116° 09′ 50.39″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Tecate	75 11 55.34	254 54 57.26	4.7069262
Campo	77 20 35.08	257 08 16.09	4.5633149
Laguna	125 28 20.44	305 20 39.78	4.4342291
Whale	158 56 04.52	338 51 08.21	4.5957727
Eagle	206 03 45.76	26 09 03.31	4.5391935
Coyote	224 40 23.63	44 45 14.49	4.2985400
Signal Mountain	280 56 25.30	101 11 09.41	4.6384900

LAGUNA, SAN DIEGO COUNTY.

On probably the highest point in the Laguna range of mountains, near the headwaters of Cottonwood Creek. It can not be reached except on horseback, but animals can be easily ridden to it. The only

people living near by are the Indians on the north side. Mr. Peter McCain lives about 9 miles southeast, and there is a trail from his ranch to the Indian settlement, thence to Laguna settlement, thence to Cuyamaca. The station is about 1.5 miles south from the Indian settlement. There is another peak about 0.25 mile southeast from station almost as high.

Signal: A rock 10 or 12 feet high on top of a ledge of rocks. A small tree was placed in rocks about 12 feet north of station.

Station mark: A triangulation tablet cemented in center of top of rock.

[Latitude 32° 50′ 23.47″. Longitude 116° 24′ 01.49″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Campo	29 33 41.04	209 29 00.83	4.4374836
Tecate	43 08 57.56	222 59 37.41	4.5969522
Cuyamaca	121 41 29.06	301 34 46.62	4.3545285
Whale	200 37 21.91	20 40 07.76	4.3517246
Eagle	247 34 00.49	67 47 01.06	4.6059486
Coyote	272 27 26.61	92 39 59.49	4.5581308
Jacumba	305 20 39.78	125 28 20.44	4.4342291

LUCKY, SAN DIEGO COUNTY.

On a low, sandy hill, covered with very soft sandstone, about 10 miles a little north of west from Imperial and about 3 miles west of New River bridge near Blue Lake or Silsbu. One can drive within 100 yards of station.

Station mark: A standard bench-mark post set in ground under center of cairn 8 feet high.

[Latitude 32° 53′ 58.67″. Longitude 115° 44′ 10.37″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Coyote	72 35 01.37	252 25 57.37	4.4366284
Eagle	109 28 28.96	289 19 50.00	4.4197360
Brawley	246 06 12.43	66 12 44.58	4.3114329
Imperial	287 29 23.41	107 35 03.03	4.2319021
Signal Mountain	355 13 45.15	175 14 38.32	4.4885433

MESQUITE, SAN DIEGO COUNTY.

On a sandhill with mesquite brush growing on it about 2½ or 3 miles northeast from monument 217, United States and Mexico boundary. It is the highest of several sandhills in the vicinity.

Signal: A lumber tripod 12 feet high with pole and target extending 7 feet higher.

Station mark: A standard bench-mark post set 40 inches in the sand under center of signal. (Probably permanent.)

[Latitude 32° 41′ 54.73″. Longitude 115° 16′ 24.51″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sharp	77 39 16.65	257 35 35.29	4.0386893
Holtville	137 11 04.44	317 07 26.77	4.1876380
Hog	197 59 03.27	18 00 17.91	4.0654886
Gravel	273 34 15.82	93 39 02.85	4.1306964

PILOT, SAN DIEGO COUNTY.

A station of the United States and Mexico Boundary Commission, on the highest point of a butte of the same name, about 10 miles west of Yuma on the California side of the Colorado River. Reached from Yuma by crossing the river on the ferry and taking road through the Indian reservation to old stage station, where one strikes the Southern Pacific Railroad again. Follow road along south side of railroad for 2 miles, then turn off across country to foot of butte.

Station mark: No mark was put in by the Boundary Commission, and the signal had blown down. A rock monument 6 feet high was built over center, as nearly as it could be determined.

Reference mark: A bronze triangulation tablet cemented in solid rock; true azimuth from rock monument, 242° 07′; distance, 11.3 feet.

[[a] Latitude 32° 43′ 53.83″. Longitude 114° 44′ 49.68″.]
[[b] Latitude 32° 43′ 55.42″. Longitude 114° 44′ 47.99″.]
[[c] Latitude 32° 43′ 56.57″. Longitude 114° 44′ 47.07″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sandy	84 06 28.27	264 01 50.97	4.1280182
Blizzard	116 30 59.56	296 23 37.86	4.3750165
American [c]	177 44 13.23	357 44 01.80	4.1430929
American [b]	177 44 15.19	357 44 03.76	4.1430949
Ridge	223 15 29.56	43 21 27.24	4.3984893
Sugarloaf	254 53 04.41	75 01 33.12	4.4037670
Yuma, azimuth station	280 44 17.76	100 48 27.64	4.0882718
Yuma, azimuth station [a]	280 43 45.30	100 47 55.20	4.0882420

[a] Yuma data, United States and Mexico Boundary Commission.
[b] Lake Tahoe.
[c] From Cuyamaca-Tecate United States standard.

SANDY, SAN DIEGO COUNTY.

On the highest point near the southeast end of long range of sand hills, about 1.5 miles northeast from monument 210 on United States and Mexico boundary.

Signal: A lumber tripod.

Station mark: A 2 by 3 inch stake set in sand under center of tripod. No bench mark available at time this station was occupied, and it is impossible to preserve center accurately, as the hill is constantly moving.

[Latitude 32° 43′ 11.53″. Longitude 114° 53′ 19.99″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Gravel	81 57 26.19	261 49 37.80	4.3580589
Blizzard	146 36 52.18	326 34 08.21	4.1558855
American	219 54 43.91	39 59 10.25	4.2995209
Pilot Knob	264 01 50.97	84 06 28.27	4.1280182

SHARP, SAN DIEGO COUNTY.

On the highest point of low sand hills about 8 miles east from Calexico and about one-fourth mile north of the United States and Mexico boundary.

Signal: A lumber tripod 12 feet high.

Station mark: A standard bench-mark post set 40 inches in the sand under center of signal. (This hill is constantly drifting and mark may be covered or blown out of the ground at any time.)

[Latitude 32° 40′ 38.67″. Longitude 115° 23′ 14.39″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Holtville	180 49 09.89	0 49 13.95	4.1347675
Hog	226 44 40.06	46 49 36.34	4.2916431
Mesquite	257 35 35.29	77 39 16.65	4.0386893

SIGNAL MOUNTAIN, LOWER CALIFORNIA, MEXICO.

On the more eastern of the two highest points on Signal Mountain, a well-known mountain about 12 miles from Calexico. It is on the Mexican side of the boundary about 1½ miles below the line. Monument No. 224 is at the foot of mountain.

Station mark: A rock cairn 6 feet at base and 9 feet high. (There is a cairn about 4 feet high on the southwest summit.)

[Latitude 32° 37′ 21.29″. Longitude 115° 42′ 32.11″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Jacumba	101 11 09.41	280 56 25.30	4.6384900
Coyote	128 11 09.34	308 01 14.25	4.5614279
Eagle	145 17 29.60	325 07 59.34	4.6812910
Lucky	175 14 38.32	355 13 45.15	4.4885433
Imperial	208 12 42.40	28 17 27.61	4.4625328
Holtville	236 53 59.98	57 04 29.68	4.5585846

SUNSET, SAN DIEGO COUNTY.

On a sand-hill with mesquite brush on it, about 4 miles a little south of east from Sunset Spring, from which place it can be easily reached. The point is about one-half mile east from the line of the "old beach."

Signal: A lumber tripod 14 feet high with targets extending 6 feet higher.

Station mark: A standard bench-mark post set 40 inches in the sand under center of signal. (Probably permanent.)

[Latitude 32° 56′ 05.10″. Longitude 115° 16′ 35.57″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Holtville	34 21 09.15	214 17 36.78	4.2563137
Imperial	71 21 23.28	251 12 04.37	4.4509094
Brawley	100 15 10.03	280 06 42.20	4.3915585
Hogue	162 05 10.61	342 03 37.74	4.1578776
Hardy	288 47 25.62	108 53 49.36	4.2877086
Hog	345 37 47.15	165 39 08.03	4.1938152

TECATE, SAN DIEGO COUNTY.

A station of the United States Coast and Geodetic Survey. It is not on the highest point of the mountain. The highest point is marked by a cairn of stones, and, as one can not see monument 246 from this point, a point southeast, distant about 40 feet, was selected, from which one sees both monuments--246 and 245. To reach station from Potrero, on road from San Diego to Campo, drive south about 6 miles to store and saloon of Mr. Brown, on boundary. Here the old trail made by the Boundary Commission leads to monument 246. The trail was grown up with bushes in 1899, and was very rough. From monument 246 to station, Tecate, a trail had to be cut. Pack animals can be obtained at the ranch of Mr. Manuel Flores.

Station mark: A hole drilled in solid rock.

Reference marks: One in line to Cuyamaca, distant 3.77 feet; one in line to Lion's Head, distant 4.14 feet; one in line to San Miguel, distant 9.81 feet.

[United States standard. Latitude 32° 34′ 45.99″. Longitude 116° 41′ 18.06″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
San Miguel	119 15 52.1	299 07 51.4	4.425106
Cuyamaca	190 40 09.9	10 42 49.8	4.617669
Laguna	222 59 37.41	43 08 57.56	4.5969522
Campo	249 28 18.54	69 32 57.82	4.1592400
Jacumba	254 54 57.26	75 11 55.34	4.7069262

WHALE, SAN DIEGO COUNTY.

On the highest point of a high rocky ridge north-northeast from the old Vallicita stage station, on road from Julian to Yuma, and 24 miles from Julian. The point is about 5 miles straight from stage station, and summit is covered with bowlders and small trees. Horses can be ridden up the "wash" to foot of mountain. From this point to summit it is both steep and rough. There is very fair water at the old stage station, but no forage closer than Julian.

Station mark: A triangulation tablet cemented in solid rock under center of a cairn 6 feet high.

[Latitude 33° 01′ 46.23″. Longitude 116° 18′ 56.44″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Laguna	20 40 07.76	200 37 21.91	4.3517240
Cuyamaca	71 25 40.89	251 16 11.33	4.4573560
Eagle	280 53 55.40	101 04 11.80	4.4760237
Coyote	308 44 08.24	128 53 57.23	4.5578864
Jacumba	338 51 08.21	158 56 04.52	4.5957727

COLORADO.

SECONDARY TRIANGULATION STATIONS.

CLEAR CREEK AND GILPIN COUNTIES.

CENTRAL CITY, IDAHO SPRINGS, AND SILVER PLUME SPECIAL QUADRANGLES.

During the season of 1904 Mr. Frank Tweedy, topographer, located 36 secondary triangulation points for the control of the three special quadrangles mentioned above.

Positions are based upon Central, Democrat, Grindal, and Kingston *United States standard* datum.

AVON, GILPIN COUNTY.

On a small knob, 0.2 mile northeast of Avon mine.
Station mark: Center of a cairn.
(Latitude 39° 47′ 39.32″. Longitude 105° 31′ 17.39″.)

BELLEVUE, CLEAR CREEK COUNTY.

On Bellevue Mountain, 1 mile northwest of Idaho Springs.
Station mark: A cairn erected over triangulation tablet cemented in bed rock.
(Latitude 39° 45′ 50.07″. Longitude 105° 32′ 30.03″.)

BLACKHAWK, GILPIN COUNTY.

Bare hill summit above (south of) Blackhawk (town).
Station mark: A bronze triangulation tablet cemented in solid rock and surrounded by a cairn.
(Latitude 39° 47′ 29.23″. Longitude 105° 29′ 06.81.″)

BLACKHAWK STATION, GILPIN COUNTY.

Station mark: Chimney of Blackhawk railroad station.
(Latitude 39° 48′ 07.10″. Longitude 105° 29′ 34.21″.)

CENTRAL CITY, CATHOLIC SEMINARY, GILPIN COUNTY.

Cross on Catholic Seminary on hill southwest of Central City.
Station mark: Center of cross.
(Latitude 39° 47′ 59.80″. Longitude 105° 30′ 49.96″.)

CORY CITY, CLEAR CREEK COUNTY.

Boarding house of Cory City mine above Silver Plume (town).
(Latitude 39° 42′ 02.95″. Longitude 105° 43′ 43.87″.)

CROWN POINT, CLEAR CREEK COUNTY

Flagstaff on shaft hoist of Crown Point mine at head of Virginia Canyon, north of Idaho Springs.
Station mark: Center of flagstaff.
(Latitude 39° 46′ 15.23″. Longitude 105° 32′ 22.40″.)

EAGLE, CLEAR CREEK COUNTY.

High rocky butte at end of ridge in forks of Trail Creek and Clear Creek, opposite mouth of Fall River. Identical with triangulation station of engineers of Idaho Springs and Central City.
Station mark: A cairn.
(Latitude 39° 45′ 09.52″. Longitude 105° 33′ 27.42″.)

FLIRTATION, CLEAR CREEK COUNTY.

On Flirtation Hill, 0.5 mile south of Idaho Springs.
Station mark: A cairn erected over bronze triangulation tablet cemented in bed rock.
(Latitude 39° 44′ 05.51″. Longitude 105° 31′ 10.78″.)

FREEDOM, GILPIN COUNTY.

Shaft hoist of Freedom mine, north of Central City.
Station mark: Center of hoist.
(Latitude 39° 48′ 08.43″. Longitude 105° 30′ 27.08″.)

GRIFFIN'S MONUMENT, CLEAR CREEK COUNTY.

Clifford Griffin's grave monument near 7–30 mine above Silver Plume (town).
Station mark: Center of monument.
(Latitude 39° 42′ 04.95″. Longitude 105° 44′ 25.47″.)

HIGH MINE PEWABIC, CLEAR CREEK COUNTY.

Shaft hoist of highest mine on south slope of Pewabic Mountains north of Idaho Springs.
Station mark: Center of hoist.
(Latitude 39° 46′ 02.25″. Longitude 105° 31′ 25.17″.)

HIGH RED, CLEAR CREEK COUNTY.

The most western of two large deserted red-roofed mines on south slope of Pewabic Mountain.
(Latitude 39° 45′ 45.91″. Longitude 105° 30′ 58.96″.)

IDAHO SPRINGS, CLEAR CREEK COUNTY.

Spire at northeast corner of Idaho Springs.
Station mark: Center of spire.
(Latitude 39° 44′ 33.85″. Longitude 105° 31′ 05.10″.)

JUSTICE, GILPIN COUNTY.

Shaft hoist of Justice mine 1 mile south of Blackhawk (town).
Station mark: Center of hoist.
(Latitude 39° 47′ 01.15″. Longitude 105° 29′ 22.37″.)

KNOB ROAD, CLEAR CREEK COUNTY.

Small knob at bend of road to Sun and Moon mine 1.2 miles northeast of Idaho Springs.
Station mark: A cairn.
(Latitude 39° 45′ 27.00″. Longitude 105° 30′ 26.58″.)

LAKE, GILPIN COUNTY.

On a flat hill 0.5 mile south of Central City and 0.12 mile east of dry lake on divide.

Station mark: A bronze triangulation tablet cemented in solid rock and surmounted by a cairn.

(Latitude 39° 47′ 33.69″. Longitude 105° 30′ 20.86″.)

LEAVENWORTH, CLEAR CREEK COUNTY.

A bare knob on Leavenworth Mountain 1 mile east of town of Silver Plume and 1 mile south of Georgetown. (Identical with a triangulation station of the mining engineers of Georgetown.)

Station mark: A cairn erected over a bronze triangulation tablet cemented in rock.

(Latitude 39° 41′ 31.00″. Longitude 105° 42′ 13.24″.)

LONE TREE, GILPIN COUNTY.

Cloth about trunk of lone pine tree on hill 0.5 mile north of Sun and Moon mine.

(Latitude 39° 46′ 24.65″. Longitude 105° 30′ 25.93″.)

MARYLAND, GILPIN COUNTY.

On summit of Maryland Mountain north of Central City.

Station mark: A bronze triangulation tablet cemented in bed rock surmounted by a cairn.

(Latitude 39° 48′ 45.01″. Longitude 105° 30′ 18.30″.)

NEVADA, GILPIN COUNTY.

Nevada mine west of Nevadaville.

Station mark: Center of building.

(Latitude 39° 47′ 47.70″. Longitude 105° 32′ 12.01″.)

NORTHWEST, GILPIN COUNTY.

On a bare hill 1 mile northwest of Central City.

Station mark: Center of a cairn.

(Latitude 39° 48′ 28.61″. Longitude 105° 31′ 28.45″.)

OLDTOWN, GILPIN COUNTY.

Smokestack of Oldtown mine 0.25 mile east of town of Russell Gulch.

Station mark: Center of smokestack.

(Latitude 39° 46′ 37.87″. Longitude 105° 31′ 53.54″.)

PAY ROCK MINE, CLEAR CREEK COUNTY.

Smokestack of Pay Rock mine above Silver Plume.

Station mark: Center of smokestack.

(Latitude 39° 42′ 05.12″. Longitude 105° 43′ 28.62″.)

PENDLETON, CLEAR CREEK COUNTY.

A rock knob on Pendleton Mountain 1.5 miles southwest of town of Silver Plume. The station is on the north edge of ridge at timber line where ridge rises abruptly to the west.

Station mark: A bronze triangulation tablet cemented in bed rock.

(Latitude 39° 41′ 06.10″. Longitude 105° 44′ 14.52″.)

QUARTZITE, GILPIN COUNTY.

Knob near Alps mine.

Station mark: A bronze triangulation tablet cemented in rock and surmounted by a cairn.

(Latitude 39° 47′ 19.76″. Longitude 105° 32′ 05.32″.)

RED ROOF, CLEAR CREEK COUNTY.

The chimney of most prominent red-roofed house in group of buildings 0.12 mile southeast of Silver Plume Railroad station.

Station mark: Center of chimney.

(Latitude 39° 41′ 39.17″. Longitude 105° 43′ 18.69″.)

SARATOGA, GILPIN COUNTY.

Shaft hoist of Saratoga mine 1 mile east of Russell Gulch (town).

Station mark: Center of hoist.

(Latitude 39° 46′ 55.40″. Longitude 105° 30′ 46.28″.)

SILVER PLUME, CLEAR CREEK COUNTY.

On high granite rock rising from Silver Plume town on the north.

Station mark: A cairn erected over a bronze triangulation tablet cemented in bed rock.

(Latitude 39° 41′ 50.48″. Longitude 105° 43′ 40.63″.)

SPRING, CLEAR CREEK COUNTY.

On rocky ridge between Spring Creek and Clear Creek, 1.25 miles west of Idaho Springs.

Station mark: A cairn erected over bronze triangulation tablet cemented in bed rock.

(Latitude 39° 44′ 26.64″. Longitude 105° 32′ 20.92″.)

SUMMIT, CLEAR CREEK AND GILPIN COUNTIES.

On hill 2 miles northeast of Idaho Springs and 0.2 mile east of Summit mine. On boundary line between Clear Creek and Gilpin counties.

Station mark: A cairn erected over bronze triangulation tablet cemented in bed rock.

(Latitude 39° 45′ 46.06″. Longitude 105° 29′ 37.89″.)

SUN AND MOON MINE, CLEAR CREEK AND GILPIN COUNTIES.

Knob above (east of) Sun and Moon mine on line between Clear Creek and Gilpin counties.

Station mark: A cairn erected over bronze triangulation tablet cemented in rock.

(Latitude 39° 45′ 57.17″. Longitude 105° 30′ 34.36″.)

TARGET ROCK, GILPIN COUNTY.

On a small rocky knob above Russell Gulch, about 1 mile northeast of Russell Gulch (town).

Station mark: A bronze triangulation tablet cemented in solid rock surmounted by a cairn.

(Latitude 39° 47′ 14.11″. Longitude 105° 31′ 05.79″.)

TOPEKA, GILPIN COUNTY.

Topeka mine 0.5 mile north of Russell Gulch (town).

(Latitude 39° 46′ 58.39″. Longitude 105° 32′ 03.29″.)

TERRIBLE, CLEAR CREEK COUNTY.

On north edge of main road 100 yards east of Terrible mine.

Station mark: A bronze triangulation tablet cemented in rock.

(Latitude 39° 41′ 48.05″. Longitude 105° 44′ 32.83″.)

VIRGINIA BUTTE, CLEAR CREEK COUNTY.

Knob on south end of ridge 0.5 mile north of Idaho Springs. Identical with triangulation station of mining engineers of Central City and Idaho Springs.

Station mark: A cairn.

(Latitude 39° 44′ 57.10″. Longitude 105° 31′ 07.73″.)

TRIANGULATION STATIONS.

HINSDALE AND MINERAL COUNTIES.

CREEDE AND SAN CRISTOBAL QUADRANGLES.

Two 15-minute quadrangles (including the Creede Special) in southwestern Colorado were controlled by Mr. J. F. McBeth, topographer, who occupied nine new stations and located two points by intersections. Positions are based upon Ouray, Uncompahgre, and Sneffels, United States standard datum.

BLUFF, MINERAL COUNTY.

On western point of high bluff east of and above the town of Upper Creede. Reached by trail from Lower Creede.

Station mark: A bronze tablet cemented in solid rock, over which a tripod signal was erected.

[Latitude 37° 52′ 00.5″. Longitude 106° 54′ 45.3″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
San Luis	173 08 32.1	353 07 51.7	4.12780
Bristol	56 56 44.6	236 51 30.9	4.17407

BRISTOL, MINERAL COUNTY.

On the end of the western bluff point of Bristol Head, the southern extremity of a high mesa about 10 miles southwest of Creede and west of the Rio Grande River. The station is directly east of Lake Santa Maria. It may be reached from the northeast with pack and saddle animals.

Station mark: A bronze tablet cemented in rock, over which a cairn 3½ feet in diameter and 5½ feet high was erected.

[Latitude 37° 47′ 36.0″. Longitude 107° 03′ 16.8″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Pyramid	67 08 20.7	246 55 57.5	4.50909
Uncompahgre	130 56 50.9	310 41 50.4	4.67464
San Luis	206 51 14.9	26 55 48.7	4.38178

BULL DOG, MINERAL COUNTY.

Near south end of bluff on east side of Bull Dog Hill, about 1 mile southwest of the town of Bachelor and about 2 miles northwest of the town of Lower Creede.

Station mark: A bronze tablet cemented in solid rock, over which a small cairn was erected.

[Latitude 37° 52′ 14.0″. Longitude 106° 57′ 07.76″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Grassy	198 42 43	18 43 24	3.70615
Bluff	276 54 46	96 56 13	3.54501

BUTTE, MINERAL COUNTY.

On a rocky butte, locally known as Dickey Hill, at southeast end of a ridge lying between West Willow and Sunnyside creeks, about 1 mile northwest of the town of Bachelor.

Station mark: A bronze tablet cemented in solid rock, over which a small cairn with flag pole in center was built.

[Latitude 37° 53′ 36.9″. Longitude 106° 57′ 42.6″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Grassy	227 37 14	47 38 16	3.52638
Bluff	304 26 24	124 28 12	3.72056

GRASSY, MINERAL COUNTY.

Top of bluff at south edge of grassy bench above timber line, between East and West Willow creeks, about 2 miles northeast of the town of Bachelor and 4 miles north of Creede.

Station mark: A bronze tablet cemented in solid rock, over which a tripod signal 10 feet at base and 15 feet high was erected.

[Latitude 37° 54′ 50.4″. Longitude 106° 56′ 01.0″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bristol	38 32 34.3	218 28 06.9	4.23330
San Luis	181 43 47.5	1 43 53.7	3.90804

LA GARITA, MINERAL AND SAGUACHE COUNTIES.

On the southeastern high summit of the La Garita Mountains, opposite the head of Saguache Creek, and about 6 miles northeast of the town of Creede.

Station mark: A bronze tablet cemented in rock just beneath surface, over which a cairn 4 feet in diameter and 7 feet high was erected.

[Latitude 37° 55′ 04.6″. Longitude 106° 50′ 27.3″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Pyramid	61 36 11.4	241 15 55.5	4.74242
Uncompahgre	107 34 59.1	287 12 03.6	4.75689

SOUTH RIVER, MINERAL COUNTY.

On the summit of South River Peak, situated at the head of Red Mountain Creek, which enters the Rio Grande River from the south at the bend in river about 12 miles southwest of creek, and is at the east side of the east branch of the creek. A road reaches the basin about 1 mile distant from the peak via Red Mountain Creek. From the terminus of this road a trail leads across the divide and to Pagosa Spring.

Station mark: A bronze tablet cemented in rock, over which a cairn 3½ feet in diameter and 6 feet high was erected.

[Latitude 37° 34′ 27.1″. Longitude 106° 58′ 52.2″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Uncompahgre	142 41 49.0	322 24 08.38	4.84240
Ouray	214 58 59.4	35 26 57.00	5.06180
San Luis			4.66300
Pyramid			4.58111
Bristol			4.40102

GRAY, HINSDALE COUNTY.

(Not occupied.)

A gray peak on the divide between the Los Pruos River and Wemmuche Creek, about 12 miles south of the Rio Grande Pyramid.

Station mark: A rock monument on summit of peak.

[Latitude 37° 29′ 50.66″. Longitude 107° 22′ 32.63″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Pyramid	175 56 47	355 56 11	4.30751
South River	256 08 50	76 23 16	4.55509

UNCOMPAHGRE, HINSDALE COUNTY.

On summit of Uncompahgre Peak, a station of the transcontinental triangulation of the United States Coast and Geodetic Survey.

Station mark: A cross cut in top of ½-inch copper bolt leaded into the solid rock under masonry pier for theodolite support. The circular stone ring wall, inner diameter 11 feet, was left standing.

[Latitude 38° 04′ 18.42″. Longitude 107° 27′ 41.78″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Sneffels	75 32 46.6	255 20 34.1	4.4764217
Treasury Mountain	196 43 01.82	16 56 36.24	5.0347020
Mount Ouray	249 49 54.38	70 35 52.02	5.0611148
Lake	282 30 36.9	102 38 39.2	4.2913527
Sherman	348 59 42.2	169 01 03.2	4.2261074
South River	322 24 08.38	142 41 49.0	4.84240
Pyramid	351 57 45.6	172 00 19.5	4.64277
San Luis	281 16 04.4	101 35 41.7	4.67717
Bristol	310 41 50.4	130 56 50.9	4.67464
La Garita	287 12 03.6	107 34 59.1	4.75689

DEL NORTE, RIO GRANDE COUNTY.

(Not occupied.)

Summit of Del Norte Peak.
Station mark: A rock monument.

[Latitude 37° 35′ 23.5″. Longitude 106° 33′ 46.5″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
South River	87 25 25.0	267 10 07.0	4.56801
San Luis	143 47 01.0	323 33 29.6	4.73800

OURAY, SAGUACHE COUNTY.

A station of the United States Coast and Geodetic Survey on the summit of Mount Ouray.

[Latitude 38° 25′ 22.20″. Longitude 106° 13′ 27.33″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Bison	214 39 20.16	35 06 41.17	5.04288022
Pikes Peak	245 20 55.42	66 02 08.82	5.05221188
South River	35 26 57.00	214 58 59.40	5.06180
San Luis	52 11 55.00	231 45 41.70	4.89521

SAN LUIS, SAGUACHE COUNTY.

On summit of San Luis Peak, about 10 miles north of the town of Creede. Spring Creek heads on the southwest and Cochetopa Creek on the east side of the peak, from either of which animals can be taken to top of peak. From Creede the station may be easily reached by going up East Willow Creek, there being a wagon road to and beyond a sawmill near timber line. From this point with saddle and pack animals one crosses the divide into the head of Spring Creek and from there on to the peak.

Station mark: A bronze tablet cemented in embedded rock, over which a cairn 3½ feet in diameter and 7 feet high was erected.

[Latitude 37° 59′ 12.77″. Longitude 106° 55′ 50.9″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bristol	26 55 48.7	206 51 14.9	4.38178
Uncompahgre	101 35 41.7	281 16 04.4	4.67717
Ouray	231 45 41.7	52 11 55.0	4.89521
South River			4.66300
Pyramid			4.72430

PYRAMID, SAN JUAN COUNTY.

On the summit of the Rio Grande Pyramid, about 5 miles south of the Rio Grande River, on the divide between Ute Creek (a tributary of the Rio Grande) and the headwaters of the Los Pinos River. The Wemmuche trail passes about 3 miles east of station, from which a blazed trail leads through the woods to timber line on the east side of the peak.

Station mark: A bronze tablet cemented in solid rock, over which a cairn 4 feet in diameter and 6 feet high was erected.

[Latitude 37° 40′ 47.48″. Longitude 107° 23′ 31.1″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sneffels	135 44 50.3	315 30 07.1	4.70181
Uncompahgre	172 00 19.5	351 57 45.6	4.64277
South River			4.58111
Bristol			4.50909
San Luis			4.72430

MONTANA.

TRIANGULATION STATIONS.

CHOUTEAU AND VALLEY COUNTIES.

BIG SANDY, BOX ELDER, LONESOME SPECIAL, AND OTHER QUADRANGLES.

During the season of 1904 Mr. Fred McLaughlin connected the triangulation, which had been extended eastward from the Burnham Base to the line Galpin-Nassau of the Missouri River triangulation. This connection was made in Valley County near the junction of the Missouri and Milk rivers.

Later in the season an area of about 1,000 square miles was controlled, extending from a little north of Burnham Base, in Chouteau County, south of Burnham Base, to connect with the line Recess-Ridge of the Missouri River triangulation, then west to beyond the Marias River. The work was done under the supervision of Mr. H. L. Baldwin, jr.; eight old stations were reoccupied, including those of the Missouri River Commission, and eighteen new ones were selected and occupied. The latitude adopted is that of international boundary monument No. 318, corrected graphically for station error to the mean parallel of 49° 00′ 04.90″.

The longitude depends upon the astronomic longitude of the schoolhouse and church spire at Chinook, as determined by the United States Coast and Geodetic Survey in the fall of 1903.

BIG SANDY, CHOUTEAU COUNTY.

A prominent point on ridge 3 miles east of Big Sandy Railroad station, 239 feet west of section corner, 0.25 mile northwest of wagon road.

Station mark: An iron bench-mark post set 36 inches in the ground.

[Latitude 48° 09′ 46.48″. Longitude 110° 01′ 49.12″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Mill	110 42 44.01	290 36 20.85	4.0550209
Sage	153 36 00.51	333 29 27.59	4.3870191
Square	202 55 35.70	23 00 21.51	4.3065580
Coulee	149 24 57.57	329 21 43.12	4.0243339

BLACK, CHOUTEAU COUNTY.

On Black Butte, 1.5 miles south of Big Sandy-Marias road and 1 mile east of Black Coulee.

Station mark: An iron bench-mark post set 36 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 342° 58′; distant 4.85 feet from station; a bottle 8 inches underground, true azimuth, 168° 28′; distant 5.39 feet from station.

[Latitude 48° 14′ 15.94″. Longitude 110° 32′ 37.78″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Discovery	21 39 36.53	201 36 48.70	4.1008816
Shepard	65 25 32.31	245 16 33.69	4.2151397
Marias	114 44 57.78	294 36 43.08	4.1774275
Lonesome	218 50 04.77	38 55 48.78	4.1799026
High	284 10 46.44	104 20 26.23	4.2190437
Carp	311 34 45.24	131 44 37.28	4.2953139

BOX, CHOUTEAU COUNTY.

On prominent hill about 19 miles west and 5 miles north of Box Elder railroad station.

Station mark: An iron bench-mark post set 40 inches in ground.

Reference marks: A bottle 8 inches underground, true azimuth, 175° 01′; distant 5.53 feet from station; bottle 8 inches underground, true azimuth, 7° 34′; distant 4.7 feet from station.

[Latitude 48° 25′ 37.42″. Longitude 110° 22′ 50.44″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Lonesome	15 41 56.59	195 40 22.00	3.9835522
Van	232 24 48.85	52 29 58.88	4.0363203
Line	306 21 05.42	126 26 33.79	4.0500828
Reservoir	346 05 58.19	166 06 45.40	3.7329844

BROWN, CHOUTEAU COUNTY.

On a flat hill 12 miles north of Burnham railroad station, near head of Browns Coulee and just west of Cottonwood Coulee.

Station mark: An iron bench-mark post set 36 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 163° 03″; distant 8.2 feet from station; a bottle 8 inches underground, true azimuth, 347° 52′; distant 8.2 feet from station.

[Latitude 48° 44′ 28.46″. Longitude 109″ 57′ 10.88″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chain Lake	23 03 00.90	203 00 16.41	4.0587203
Mile board 984	42 05 54.14	221 56 09.44	4.3767324
Corral	77 56 43.00	257 47 00.38	4.2096585

CARP, CHOUTEAU COUNTY.

On south end of ridge overlooking the Missouri River Valley, and about 11 miles southwest of Big Sandy railroad station. Two and one-half miles north of railroad grade.

Station mark: An iron bench-mark post set 36 inches in the ground.

Reference marks: Bottle 8 inches underground, true azimuth, 185° 16′; distant 3.5 feet from station; bottle 8 inches underground, true azimuth, 335° 19′; distant 6.4 feet from station.

[Latitude 48° 07′ 11.22″. Longitude 110° 20′ 43.86″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ridge	25 24 48.28	205 20 46.11	4.1967209
Discovery	....	....	4.28938
Black	131 44 37.28	311 34 45.24	4.2953139
High	188 16 51.98	8 16 39.35	3.9606906
Verona	249 16 30.18	69 20 22.89	3.8393100
Recess	356 13 08.45	176 13 35.93	4.0649199

CORRAL, CHOUTEAU COUNTY.

On rolling prairie 10 miles northwest of Kremlin railroad station; 0.75 mile northwest of a small house and sheep corral.

Station mark: An iron bench-mark post set 40 inches in the ground.

Reference marks: Chiseled cross mark on 8 pound rock 10 inches underground, true azimuth, 312° 34′; distant 7.3 feet from station; chiseled cross mark on a 25 pound rock (granite), 6 inches underground, true azimuth, 130° 12′; distant 5.25 feet from station.

[Latitude 48° 42′ 38.18″. Longitude 110° 10′ 06.08″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Mile board 984	0 17 35.08	180 17 32.41	4.1547835
Brown	77 56 43.00	257 47 00.38	4.2096585
Chain Lake	302 00 33.07	122 07 30.81	4.1279905

COULEE, CHOUTEAU COUNTY.

On east bank of Lonesome Lake Coulee, 6 miles southwest of Box Elder railroad station and 2 miles west of railroad track.

Station mark: An iron bench-mark post set 40 inches in ground.

Reference marks: Bottle 8 inches underground, true azimuth, 174° 40′; distant 5.8 feet from station; bottle 8 inches underground, true azimuth, 358° 16′; distant 5.7 feet from station.

[Latitude 48° 14′ 41.17″. Longitude 110° 06′ 09.95″.

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Mill	45 45 07.24	225 41 58.34	3.8634744
Big Sandy	329 21 43.12	149 24 57.57	4.0243339

DISCOVERY, CHOUTEAU COUNTY.

On Discovery Butte, about 5 miles southeast of the junction of Marias River and Black Coulee.

Station mark: An iron bench-mark post set 36 inches in ground.

Reference marks: A bottle 8 inches underground, true azimuth, 170° 33′; distant 5.62 feet from station; a bottle 8 inches underground, true azimuth, 344° 15′; distant 5.78 feet from station.

[Latitude 48° 07′ 56.30″. Longitude 110° 36′ 22.96″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Humphrey	1 00 30.13	181 00 26.73	3.7297810
Shepard	115 27 32.76	295 21 22.35	4.0560413
Black	201 36 48.70	21 39 36.53	4.1008816
High	249 38 15.87	69 50 42.96	4.3440933

FLAT, CHOUTEAU COUNTY.

On flat prairie about 5 miles south of Kremlin railroad station, 1.5 miles south of wagon road, and 3.5 miles north of Sage Creek.

Station mark: An iron bench-mark post set 40 inches in ground.

Reference marks: A bottle 8 inches underground, true azimuth, 353° 59′; distant 5.3 feet from station; a bottle 8 inches underground, true azimuth, 179° 06′; distant 5.9 feet from station.

[Latitude 48° 30′ 25.46″. Longitude 110° 04′ 29.34″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sage	24 38 40.11	204 34 06.01	4.2573438
Van			4.15158
Square	330 17 09.63	150 23 56.04	4.3536683
Laredo			3.83983

HIGH, CHOUTEAU COUNTY.

On east end of gently sloping ridge 2 miles south of Big Sandy-Marias road and 10 miles west of Big Sandy railroad station.

Station mark: An iron bench-mark post set 36 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 174° 31′; distant 4 feet from station; a bottle 8 inches underground, true azimuth, 350° 16′; distant 4 feet from station.

[Latitude 48° 12′ 03.88″. Longitude 110° 19′ 40.27″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Carp	8 16 39.35	188 16 51.98	3.9606906
Humphrey	58 05 58.74	237 53 28.53	4.3901382
Discovery	69 50 42.96	249 38 15.87	4.3440933
Black	104 20 26.23	284 10 46.44	4.2190437
Lonesome	157 39 05.60	337 35 09.24	4.2342733
Line	195 30 17.59	15 33 23.42	4.2826006
Mill	271 08 13.02	91 15 08.26	4.0608721
Verona	322 02 35.14	142 05 40.61	3.9225304

HUMPHREY, CHOUTEAU COUNTY.

On highest point of ridge running east and west, about 3 miles east of the Marias River and 9 miles south of the junction of the Marias River and the Black Coulee. A road runs 0.25 mile west of station.

Station mark: An iron bench-mark post set 40 inches in ground.

Reference marks: A bottle 8 inches underground, true azimuth, 301° 29′; distant 4 feet from station; a bottle 8 inches underground, true azimuth, 162° 24′; distant 5.95 feet from station.

[Latitude 48° 05′ 02.55″. Longitude 110° 36′ 27.53″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Shepard	135 13 18.54	315 07 11.66	4.1598755
Discovery	181 00 26.73	1 00 30.13	3.7297810
High	237 53 28.53	58 05 58.74	4.3901382

LAREDO, CHOUTEAU COUNTY.

Nine miles north of Box Elder railroad station, on divide between Big Sandy Creek and Sage Creek. The nearest point of Sage Creek is 1.5 miles southwest of station.

Station mark: An iron bench-mark post set 40 inches in ground.

Reference marks: A bottle set 8 inches underground, true azimuth, 20° 27′; distant 4.3 feet from station; bottle 8 inches underground, true azimuth, 311° 59′; distant 4.3 feet from station.

[Latitude 48° 27′ 00.59″. Longitude 110° 02′ 13.65″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Sage	45 38 28.45	225 32 13.00	4.1600133
Flat	....	....	3.83983
Square	327 42 27.62	147 47 32.40	4.1963374
Big Sandy	....	....	4.50442

LINE, CHOUTEAU COUNTY.

On highest part of ridge 11 miles west of Box Elder railroad station.

Station mark: An iron bench-mark post set 40 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 346° 08′; distant 4.2 feet from station; bottle 8 inches underground, true azimuth, 149° 43′; distant 4.3 feet from station.

[Latitude 48° 22′ 01.83″. Longitude 110° 15′ 31.31″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
High	15 33 23.42	195 30 17.59	4.2826006
Lonesome	77 25 21.66	257 18 18.96	4.0767943
Reservoir	100 21 55.89	280 17 14.83	3.8957258
Box	126 26 33.79	306 21 05.42	4.0500828
Van	178 16 02.83	358 15 48.20	4.1235384
Sage	278 15 50.51	98 19 31.45	3.7888281
Mill	341 13 05.39	161 16 55.33	4.2957320

LONESOME, CHOUTEAU COUNTY.

On flat ridge about 18 miles northwest of Big Sandy railroad station and 6 miles northeast of Jack Godfrey's ranch.

Station mark: An iron bench-mark post set 36 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 111° 22′; distant from station, 5.3 feet; bottle 8 inches underground, true azimuth, 296° 32′; distant 3.2 feet from station.

[Latitude 48° 20′ 37.31″. Longitude 110° 24′ 56.96″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Black	38 55 48.78	218 50 04.77	4.1799026
Box	195 40 22.00	15 41 56.59	3.9835522
Reservoir	224 08 09.84	44 10 31.57	3.7485044
Line	257 18 18.96	77 25 21.66	4.0767943
High	337 35 09.24	157 39 05.60	4.2342733

MARIAS, CHOUTEAU COUNTY.

On a small knoll 3 miles north of Marias River, 6 miles west of Black Coulee, and 0.5 mile north of Marias road.

Station mark: An iron bench-mark post set 36 inches in ground.

Reference marks: A bottle 8 inches underground, true azimuth, 4° 47′; distant 4 feet from station; a bottle 8 inches underground, true azimuth, 180° 33′; distant 4 feet from station.

[Latitude 48° 17′ 39.35″. Longitude 110° 43′ 40.71″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Shepard	5 20 55.56	185 20 11.19	4.1200624
Black	294 36 43.08	114 44 57.78	4.1774275

MILL, CHOUTEAU COUNTY.

On rolling prairie 3 miles west of Big Sandy railroad station, just north of road from Big Sandy to Marias River.

Station mark: An iron bench-mark post set 40 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 135° 05′; distant 4.55 feet from station; a bottle 8 inches underground, true azimuth, 326° 41′; distant 4.74 feet from station.

[Latitude 48° 11′ 56.12″. Longitude 110° 10′ 23.26″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Verona	45 03 44.78	224 59 55.21	3.9541367
High	91 15 08.26	271 08 13.02	4.0608721
Line	161 16 55.33	341 13 05.39	4.2957320
Sage	179 10 38.74	359 10 29.46	4.2509978
Square	231 32 45.11	51 43 54.66	4.3728957
Big Sandy	290 36 20.85	110 42 44.01	4.0550209
Coulee	225 41 58.34	45 45 07.24	3.8634744

RECESS, CHOUTEAU COUNTY.

A station of the Missouri River Commission, on the left bank on a very prominent bluff, about 1 mile back from the river, at the head of a picturesque valley.

Station mark: An iron post set in the ground.

[Latitude 48° 00′ 56.06″. Longitude 110° 20′ 06.91″.]
[Latitude 48° 00′ 49.09″. Longitude 110° 20′ 01.91″.[a]]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ridge	70 47 09.56	250 42 40.13	3.9009046
		[a] 250 42 40.10	3.9008760
Carp	176 13 35.93	356 13 08.45	4.0649199
Verona	202 05 50.02	22 09 15.04	4.1802115

[a] By Missouri River Commission.

RESERVOIR, CHOUTEAU COUNTY.

On a slight ridge running north and south, about 16 miles west of Box Elder railroad station and 2 miles southwest of a large alkali well.

Station mark: An iron bench-mark post set 40 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 168° 14′; distant 4.2 feet from station; a bottle 8 inches underground, true azimuth, 332° 31′; distant 5.1 feet from station.

[Latitude 48° 22′ 47.48″. Longitude 110° 21′ 47.31″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Lonesome	44 10 31.57	224 08 09.84	3.7485044
Box	166 06 45.40	346 05 58.19	3.7329844
Van	211 38 18.95	31 42 45.64	4.1446635
Line	280 17 14.83	100 21 55.89	3.8957258

RIDGE, CHOUTEAU COUNTY.

A station of the Missouri River Commission, on the left bank on a very high ridge, about 3 miles from the river. The ridge has a cut face and can be seen from a long distance.

Station mark: An iron post set in the ground.

[Latitude 47° 59′ 31.09″. Longitude 110° 26′ 09.44″.]
[Latitude 47° 59′ 24.12″. Longitude 110° 26′ 04.38″.[a]]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Carp	205 20 46.11	25 24 48.28	4.1967209
Verona	218 21 32.90	38 29 27.59	4.3274788
Recess	250 42 40.13	70 47 09.56	3.9009046
	[a]250 42 40.10	....	3.9008760

[a] Missouri River Commission.

SAGE, CHOUTEAU COUNTY.

About 9 miles west of Box Elder railroad station, on small ridge on divide south of Sage Creek, 3 miles west of wagon road, 1.5 miles west of deserted house.

Station mark: An iron bench-mark post set 36 inches in the ground.

[Latitude 48° 21′ 33.12″. Longitude 110° 10′ 35.69″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Line	98 19 31.45	278 15 50.51	3.7888281
Mileboard 984	181 14 00.09	361 14 19.59	4.3944632
Square	279 31 41.98	99 43 01.65	4.2787245
Big Sandy	333 29 27.59	153 36 00.51	4.3870191
Mill	359 10 29.46	179 10 38.74	4.2509978

SHEPARD, CHOUTEAU COUNTY.

On south end of Shepards Ridge about 6 miles southwest of the junction of Marias River and Black Coulee.

Station mark: An iron bench-mark post set 36 inches in ground.

Reference marks: A bottle 8 inches underground, true azimuth, 0° 19′; distant 5.22 feet from station; a bottle 8 inches underground, true azimuth, 182° 10′; distant 7.63 feet from station.

[Latitude 48° 10′ 34.35″. Longitude 110° 44′ 40.20″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Marias	185 20 11.19	5 20 55.56	4.1200624
Black	245 16 33.69	65 25 32.31	4.2151397
Discovery	295 21 22.35	115 27 32.76	4.0560413
Humphrey	315 07 11.66	135 13 18.54	4.1598755

VAN, CHOUTEAU COUNTY.

On small ridge about 4 miles south of Gildford railroad station and 3 miles west of Van Alstine's house, which is on Sage Creek.

Station mark: An iron bench-mark post set 40 inches in the ground.

Reference marks: Bottle 8 inches underground, true azimuth, 347° 21′; distant 6.19 feet from station; bottle 8 inches underground, true azimuth, 173° 01′; distant 6.24 feet from station.

[Latitude 48° 29′ 11.90″. Longitude 110° 15′ 50.88″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Reservoir	31 42 45.64	211 38 18.95	4.1446635
Box	52 29 58.88	232 24 48.85	4.0363203
Line	358 15 48.20	178 16 02.83	4.1235384

VERONA, CHOUTEAU COUNTY.

On very prominent knoll about 6 miles southwest of Big Sandy railroad station.

Station mark: An iron bench-mark post set 40 inches in the ground.

Reference marks: A bottle 8 inches underground, true azimuth, 222° 47′; distant 4.4 feet from station; a bottle 8 inches underground, true azimuth, 39° 01′; distant 4.4 feet from station.

[Latitude 48° 08′ 30.24″. Longitude 110° 15′ 31.36″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Coalbanks			4.04123
Recess	22 09 15.04	202 05 50.02	4.1802115
Ridge	38 29 27.59	218 21 32.90	4.3274788
Carp	69 20 22.89	249 16 30.18	3.8393100
High	142 05 40.61	322 02 35.14	3.9225304
Mill	224 59 55.21	45 03 44.78	3.9541367

GALPIN, VALLEY COUNTY.

A station of the Missouri River Commission, on the left bank on divide between Missouri and Milk rivers and on rolling prairie. Station is about 3 miles from river. Lion Butte bears S. 41° 13′ E. (true), and is about 9 miles distant. Tiger Butte bears N. 29° 46′ west true), and is about 5 miles distant.

Station mark: An iron post set in the ground.

[Latitude 48° 05′ 17.67″. Longitude 106° 26′ 06.81″.[a]]
[Latitude 48° 05′ 24.75″. Longitude 106° 26′ 09.95″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Willow	95 48 15.52	275 39 25.12	4.1708246
Tiger Butte	119 42 52.76	299 38 36.81	3.9130999
Porcupine	182 02 34.78	2 02 59.96	4.2909160
Nassau	266 28 10.94	86 33 56.54	3.9834804
		[a]86 34 01.75	3.9834666

[a] Missouri River Commission.

NASSAU, VALLEY COUNTY.

A station of the Missouri River Commission, on the left bank, southwesterly from the nearest point of Milk River, 1 mile distant and about 2 miles above junction of the two rivers. Station is on the third ridge northerly from a sheep ranch. Kintyre railroad station bears south 79° 04′ E. (true), and is 8 miles distant from station.

Station mark: An iron post set in ground.

[Latitude 48° 05′ 43.70″. Longitude 106° 18′ 25.58″.]
[Latitude 48° 05′ 36.59″. Longitude 106° 18′ 22.52″.[a]]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Galpin	86 33 56.54	266 28 10.94	3.9834804
	[a]86 34 01.75	....	3.9834666
Tiger	101 48 19.74	281 38 18.09	4.2323317
Porcupine	154 53 27.49	334 48 06.59	4.3207044

[a] Missouri River Commission.

TIGER BUTTE, VALLEY COUNTY.

On a prominent butte about 5 miles east of Glasgow railroad station. This is a secondary point located by the Missouri River Commission.

Station mark: An iron bench-mark post set 36 inches in the ground.

[Latitude 48° 07′ 35.99″. Longitude 106° 31′ 53.77″.]
[Latitude 48° 07′ 29.3″. Longitude 106° 31′ 50.4″.] [a]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Willow	71 23 38.28	251 19 03.71	3.9058375
Porcupine	206 42 24.29	26 47 05.77	4.2387358
Nassau	281 38 18.09	101 48 19.74	4.2323317
Galpin	299 38 36.81	119 42 52.76	3.9130999

[a] Missouri River Commission.

CALIFORNIA-OREGON.

TRIANGULATION STATIONS.

SISKIYOU COUNTY, CAL., JACKSON AND JOSEPHINE COUNTIES, OREG.

GRANTS PASS QUADRANGLE.

In the fall of 1904 Mr. A. I. Oliver occupied nine stations for the control of the Grants Pass quadrangle. Positions are based upon Onion and Sterling stations of the Coast and Geodetic Survey, United States standard datum.

RED BUTTE, SISKIYOU COUNTY, CAL.

On the northernmost of several rocky points, commonly known as Red Buttes. The point is reached by road from Grants Pass up Applegate Run via Watkins post-office to Elbert Branch of Applegate River, thence by trail up Applegate to just beyond Cook and Green creeks; there the trail takes up ridge to left. It is two days travel from Grants Pass. The trail leads to good meadow near ridge top; but animals can not get closer than 1,000 feet of elevation of top.

Signal: A cairn 8 feet high centered over bronze tablet.

Station mark: A bronze tablet cemented in solid rock.

[Latitude 41° 55′ 49.68″. Longitude 123° 10′ 59.97″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Tannen	115 08 44.67	295 00 02.04	4.2981507
Greyback	152 01 26.24	331 56 17.01	4.3545800
Tallowbox	185 11 54.17	5 13 12.77	4.4728695
Sterling	248 23 20.02	68 35 14.57	4.4222781

STERLING, JACKSON COUNTY, OREG.

A Coast and Geodetic Survey station, but not on the point commonly known as Sterling, the latter being about 3 miles to southeast of station. A higher point than station, known as Lone Dutchman, lies north 1.5 miles distant. Reached from Grants Pass via Applegate and Ruch post-offices to Little Applegate, up Little Applegate to Crumps ranch at junction of Right and Left Fork; up Right Fork on wagon road about 3 miles, at which point take Cinnibar trail to right. The station then lies 1 mile to east and is open traveling. About 2 miles farther Donomore Flat is reached, which is a good camping place and with feed.

Signal: A tripod 15 feet high centered over tablet.

Station mark: A Coast and Geodetic Survey tablet set in solid rock.

Reference marks: One to south 34.85 meters; one to northwest 20.44 meters.

[Latitude 42° 01′ 03.94″. Longitude 122° 53′ 11.56″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Red Butte	68 35 14.57	248 23 20.02	4.4222781
Tannen	88 27 16.70	268 06 38.55	4.6292773
Greyback	106 25 27.77	286 08 22.49	4.5641402
Kerby	115 36 10.09	295 13 04.70	4.7204404
Tallowbox	132 23 44.75	312 13 07.02	4.4705344
Grants Pass	143 05 08.94	322 50 20.59	4.7022102
Onion	159 26 08.10	339 12 15.66	4.9034899

BALLY, JOSEPHINE COUNTY, OREG.

On highest summit of bald mountain, commonly known as Bally. It is reached in one day from Grants Pass by wagon toward Wilderville until crossing of Applegate and then by right-hand road to Wurtz's mill. From there good trail leads within 0.25 mile of point. Distance, 8 miles.

Signal: A trimmed tree 20 feet high with braces and wires and two targets of white cloth placed at right angles to each other.

Station mark: A bronze tablet cemented in rock and sunk flush with surface of ground.

[Latitude 42° 27′ 17.58″. Longitude 123° 36′ 55.08″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Onion	230 05 01.94	50 20 40.94	4.6148277
Grants Pass	285 32 44.05	105 47 21.61	4.4898691
Greyback	326 41 54.41	146 54 09.89	4.6603314
Kerby	333 47 53.70	153 54 09.42	4.4620608

GRANTS PASS, JOSEPHINE COUNTY, OREG.

On bare point about 4,000 feet high situated about 6 miles southeast of Grants Pass town. It is best reached by road to a gap, thence up point of ridge. No trail, but not much brush. Reached from Grants Pass in four and one-half hours.

Station mark: A bronze triangulation tablet cemented in solid rock on highest point of hill.

Reference marks: A hole 1 inch deep drilled in solid rock 11.2 feet distant southwest; a hole 1 inch deep drilled in solid rock 44.1 feet distant north.

[Latitude 42° 22′ 47.19″. Longitude 123° 15′ 14.08″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Greyback	9 03 51.09	189 01 31.38	4.4816002
Kerby	44 00 10.12	223 51 49.98	4.3897800
Bally	105 47 21.61	285 32 44.05	4.4898691
Onion	183 15 50.50	3 16 49.28	4.5410819
Sterling	322 50 20.59	143 05 08.24	4.7022102
Tallowbox	337 14 40.82	157 18 50.74	4.3430443

GREYBACK, JOSEPHINE COUNTY, OREG.

On southern and highest summit of well-known mountain of same name; reached by wagon road and trail from Grants Pass. Good camping place 0.5 mile east of monument and 1,000 feet below it.

Signal: A cairn 9 feet high.

Station mark: A bronze triangulation tablet cemented in solid rock under center of monument.

Reference marks: In solid rock, hole and arrow pointing to tablet, one to west and the other to south.

[Latitude 42° 06′ 37.03″. Longitude 123° 18′ 41.92″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Tannen	32 29 16.92	212 25 42.84	4.1364748
Kerby	134 59 52.01	314 53 52.65	4.2395960
Onion	185 55 36.49	5 58 55.27	4.8128346
Grants Pass	189 01 31.38	9 03 51.09	4.4816002
Tallowbox	234 05 18.02	54 11 46.78	4.2150949
Sterling	286 08 22.49	106 25 27.77	4.5641402
Red Butte	331 56 17.01	152 01 26.24	4.3545800
Lake	355 05 03.75	175 05 30.55	4.0310401
Bally	146 54 09.89	326 41 54.41	4.6603314

KERBY, JOSEPHINE COUNTY, OREG.

Reached by wagon road from Grants Pass via Dryden post-office, thence up Deer Creek on wagon road 2 miles past Fraks ranch, thence by trail up South Fork of Deer Creek for 4 miles to old cabin, at which point leave creek and follow partially open ridge to west which leads to peak. Nearest water is 1,500 feet lower than peak and due east in small brushy ravine. No feed other than brush.

Signal: Tripod 14 feet high exactly over tablet. Tops of trees forming tripod not trimmed off, thus forming bushy top.

Station mark: A bronze triangulation tablet cemented in rock 5 by 6 by 6 feet on highest point.

Reference marks: A hole 1 inch deep, 1 inch in diameter in rock 1 by 5 by 3 feet, and 5.4 feet to northwest of tablet, with arrow pointing from hole to tablet; another hole, same size, and arrow in same rock, 3.3 feet north of station.

[Latitude 42° 13′ 14.56″. Longitude 123° 27′ 37.22″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Tannen	348 13 55.02	168 15 59.69	4.3861224
Bally	153 54 09.42	333 47 53.70	4.4620608
Onion	199 49 50.39	19 59 10.73	4.7458616
Grants Pass	223 51 49.98	44 00 10.12	4.3897800
Sterling	295 13 04.70	115 36 10.09	4.7204404
Greyback	314 53 52.65	134 59 52.01	4.2395960
Tallowbox	275 49 14.39	96 01 43.19	4.4100119

ONION, JOSEPHINE COUNTY, OREG.

On high bald point about 18 miles north-northeast of Grants Pass; reached by wagon road via Graves and Placer post-offices. It is best to pack from Placer, distance 10 miles. Trail leaves end of wagon road and follows Graves Creek until crossing Clark Creek, the second creek; thence leave Graves Creek, turning directly to left up ridge and follow trail to forks, at which point take right-hand trail which leads to small mine at prospect. This is directly below summit about 1,500 feet, easy of ascent.

Signal: A tripod 15 feet high, bushy tree in top; 15 feet north of Coast and Geodetic Survey point. There is a spring 200 yards west of signal on hillside. Good water and feed at Onion Spring, about 1 mile to north on top of main ridge.

Station mark: Brass plate in solid rock and copper bolt beneath same.

Reference marks: One to west, 24.62 meters; one to north, 47.22 meters.

[Latitude 42° 41′ 31.88″. Longitude 123° 13′ 47.13″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Grants Pass	3 16 49.28	183 15 50.50	4.5410819
Greyback	5 58 55.27	185 55 36.49	4.8128346
Kerby	19 59 10.73	199 49 50.39	4.7458616
Bally	50 20 40.94	230 05 01.94	4.6148277
Sterling	339 12 16.66	159 26 08.10	4.9034899

TALLOWBOX, JOSEPHINE COUNTY, OREG.

On the peak known locally as Tallowbox, best reached by wagon road from Grants Pass up Applegate River to Thompson Creek, thence up Thompson Creek to Tallowbox Gulch. No trail to peak, but fairly open ridge from 1 mile up Tallowbox Gulch. Good feed on ridge side near top, and water said to be on top 0.25 mile to east of point. Station can be reached from Tallowbox ranch in Tallowbox Gulch in two hours.

Signal: A trimmed tree wired over tablet.

Station mark: A bronze tablet cemented in solid rock on highest point.

Reference marks: On same rock, one 2 feet northeast and the other 2.6 feet southeast, holes 1 inch deep and arrows drilled pointing to tablet.

[Latitude 42° 11′ 48.57″. Longitude 123° 09′ 02.66″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Red Butte	5 13 12.77	185 11 54.17	4.4728695
Greyback	54 11 46.78	234 05 18.02	4.2150949
Kerby	96 01 43.19	275 49 14.39	4.4100119
Grants Pass	157 18 50.74	337 14 46.82	4.3430443
Sterling	312 13 07.02	132 23 44.75	4.4705344

TANNEN, JOSEPHINE COUNTY, OREG.

A well-known bare peak very close to Oregon-California line. Reached by wagon road from Grants Pass to head of Williamson Creek, thence by trail past Greyback Mountain and along summit of ridge to head of Sucker Creek, down Sucker Creek about 4 miles by trail to small creek. Trail goes up this creek 2 miles to meadow and good camping place. About 1.75 miles from here by trail to peak, which can be reached with animals.

Signal: A cairn 7 feet high and small tree wired in center of same.

Station mark: A bronze tablet cemented in solid rock under center of monument.

[Latitude 42° 00′ 22.57″. Longitude 123° 24′ 01.50″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Kerby	168 15 59.69	348 13 55.02	4.3861224
Greyback	212 25 42.84	32 29 16.92	4.1364748
Sterling	268 06 38.55	88 27 16.70	4.6292773
Lake	264 05 19.53	84 09 20.19	3.9200263
Red Butte	295 00 02.04	115 08 44.67	4.2981507

SOUTH DAKOTA.

SECONDARY TRIANGULATION STATIONS.

BUTTE COUNTY.

BELLE FOURCHE PROJECT.

Early in the season of 1904 Mr. R. B. Robertson, field assistant, occupied three primary stations (Castle Rock, Owl Butte, and Susie Peak), thirteen secondary stations and located fifteen other points by intersections. Positions are given on the Rapid City astronomic datum.

BADLANDS, BUTTE COUNTY.

Near the southeast corner of T. 11 N., R. 2 E., on a sharp peak, about the highest of a ridge of "badlands" on the divide between Owl and Indian creeks. The road from Belle Fourche to Camp Crook passes about half a mile to the south of station at a point about 15 miles from Belle Fourche. Station can be seen from this road.

Signal: A lumber tripod 12 feet high.

Station mark: An iron bench-mark post marked "△" and set 3 feet in the ground.

[Latitude 44° 52′ 07.71″. Longitude 103° 48′ 32.71″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	240 56 56	61 12 16	4.51338
Number 27	296 07 48	116 16 30	4.25864
Sheep Ranch	338 46 58	158 48 44	3.96060
North Side	7 57 09	187 56 10	4.12508

CASTLE ROCK, BUTTE COUNTY.

A prominent peak in T. 12 N., R. 5 E., Black Hills meridian, 28 miles in air line northeast of Belle Fourche, 12 miles southwest of junction of Sand Creek and South Fork of Moreau River. The summit is a narrow ridge about 150 yards in length, the station being on a knob at the northern end, which is about 10 feet lower than the southern end. Road from Belle Fourche to Slim Buttes passes from southwest to northeast about 2 miles east of peak.

Station mark: A bronze triangulation tablet cemented in a flat rock buried in the ground flush with the surface.

[Latitude 45° 00′ 38.65″. Longitude 103° 26′ 50.82″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Susie Peak	36 58 45.39	216 46 29.57	4.5814773
Wymonkota	90 11 12.42	269 44 24.24	4.6971830
Owl Butte	321 26 47.25	141 36 30.14	4.4640921
Bear Butte	357 49 38.82	177 50 48.88	4.7740756
Monson	333 40 20.00	153 47 12.00	4.46189
Dry 2	352 23 15.00	172 24 55.00	4.37048
Number 27	270 24 47.00	207 18 11.00	4.42777

DOODY, BUTTE COUNTY.

In section 8, T. 9 N., R. 5 W., on the dividing ridge between Indian and Horse creeks, about half a mile southeast of the Doody ranch and 2 miles north-northwest from the junction of said creeks. Station is on the point farthest south, of any consequence, on this ridge.

Signal: A lumber tripod 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 45′ 37.61″. Longitude 103° 31′ 33.56″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	192 32 55	12 36 14	4.45481
Owl	258 14 52	78 27 53	4.39584
Tank	269 12 55	89 15 19	3.65424

DOUBLE, BUTTE COUNTY.

In section 25, T. 9 N., R. 5 E., on the point farthest north of a double hill on the divide east of Horse Creek, overlooking Horse Creek. This hill is about 1½ miles northeast of Maas and Milberg's ranch.

Signal: A lumber tripod 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 42′ 56.42″. Longitude 103° 27′ 23.18″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	181 14 19	1 14 42	4.51584
Number 27	127 49 21	307 43 09	4.16753
Tank	168 48 56	348 48 24	3.71036
Seven	334 45 53	154 47 17	3.78878
Hough	282 36 28	102 39 17	3.73366

DRY (2), BUTTE COUNTY.

About the center of section 29, T. 10 N., R. 6 E. Station is on the divide between Willow and Dry creeks, about 2½ miles northwest of Paul Kinstler's ranch, and is about 1½ miles N. 20° W. of some small peaks on same divide.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 48′ 05.08″. Longitude 103° 24′ 29.40″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	172 25 01	352 23 21	4.37048
Owl	268 08 48	88 16 50	4.17739
Number 27	88 08 16	268 00 01	4.18881
Morison	285 31 37	105 36 49	4.00459
Fourmile	317 46 50	137 55 20	4.37637
Wilson	353 08 23	173 09 30	4.24295
Number 7	364 34 43	184 34 04	4.18006
Hough	352 14 48	172 15 35	4.03386

FOURMILE, BUTTE COUNTY.

In section 24, T. 8 N., R. 7 E., on summit of the divide between Fourmile Creek and Bellefourche River; same ridge dividing Fourmile Creek and Willow Creek a little farther north. Station is 600 yards southeast, along summit from point where old Bismarck trail reaches top of divide.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 38′ 33.72″. Longitude 103° 12′ 24.04″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Dry (2)	137 55 20	317 46 50	4.37637
Owl	177 08 35	357 08 06	4.25837
Wilson	91 09 24	271 02 01	4.14295
Simmons	63 11 59	243 07 45	3.95116
B. M	106 34 04	286 33 02	3.30550

MILLER, BUTTE COUNTY.

In section 6, T. 8 N., R. 5 E., a very prominent low butte, about 2 miles north of Bellefourche River and on the divide between Owl Creek and that river, about 3 miles north and 5 miles east of Snoma post-office and 1½ miles northeast of Sorenson's ranch.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 41′ 22.03″. Longitude 103° 32′ 42.74″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	192 10 43	12 14 51	4.56266
Owl	243 23 35	63 37 24	4.46155
Twin	5 55 59	185 55 48	3.54056

MORISON, BUTTE COUNTY.

Station is in section 5, T. 9 N., R. 7 E., on a prominent flat-top hill on the divide between Jug Creek, a tributary of Butte Creek, and a branch draining into Willow Creek. A road from Aggie Morison's ranch, going northeast, passes a little to the north of station, about 2½ miles from said ranch.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post set 3 feet in the ground.

[Latitude 44° 46′ 37.21″. Longitude 103° 17′ 06.53″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ″ ′	*Meters.*
Castle Rock	153 47 12	333 40 20	4.46189
Owl	239 01 43	59 04 33	3.79144
Dry (2)	105 36 49	285 31 37	4.00459
Hogback	298 28 16	118 31 12	3.79668

NUMBER 18, BUTTE COUNTY.

In section 18, T. 9 N., R. 4 E., on the divide between Owl and Indian creeks, about 2.5 miles northwest of Owl Creek bridge and 7 miles due north of Snoma post-office. Station is close to where country breaks off abruptly to Owl Creek. Ridge rises to the northwest of station.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 44′ 55.58″. Longitude 103° 40′ 04.54″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Number 27	223 49 08	43 51 52	3.86864
Shyket	326 21 53	148 24 18	3.91217
Corner	230 10 35	50 12 00	3.42451

NUMBER 27, BUTTE COUNTY.

In section 27, T. 10 N., R. 4 E., on the farthest south and east of two round hills, lying about 2 miles northeast of the bridge across Indian Creek and 9 miles north and 12 miles east of Belle Fourche.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post, marked "△" and set 3 feet in the ground.

[Latitude 44° 47′ 48.24″. Longitude 103° 36′ 11.75″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Castle Rock	207 18 17	27 24 53	4.42777
Dry (2)	268 00 01	88 08 16	4.18881
Badlands	116 16 30	296 07 48	4.25864
Double	307 43 09	127 49 21	4.16753
Schoolhouse	118 36 41	298 34 47	3.60708
May	15 45 50	195 44 00	4.10181
Horse	323 36 39	143 39 41	3.98156
Sheep Ranch	87 49 50	267 42 54	4.11368

OWL BUTTE, BUTTE COUNTY.

A lone, bare butte in open prairie about 35 miles northeast of Sturgis, on divide east of Willow Creek. Station is near the center of summit.

Station mark: A bronze triangulation tablet cemented in rock in place.

[Latitude 44° 48′ 20.27″. Longitude 103° 13′ 05.18″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Bear Butte	23 36 51.15	203 28 22.65	4.6012777
Susie Peak	79 32 16.68	259 10 20.70	4.6212654
Castle Rock	141 36 30.14	321 26 47.25	4.4640921
Fourmile	357 08 06.00	177 08 35.00	4.25837
Hogback	358 11 24.00	178 11 30.00	3.79040
Edwards	4 51 22.00	184 50 46.00	4.11865
Willow	42 29 27.00	222 25 14.00	4.06756
Morison	59 04 33.00	239 01 43.00	3.79144
Miller	63 37 24.00	243 23 35.00	4.46155
Shyket	67 15 53.00	246 59 18.00	4.52838
Dry	73 42 32.00	253 35 53.00	4.11312
Doody	78 27 53.00	258 14 52.00	4.39584
Dry (2)	88 16 50.00	268 08 48.00	4.17739
Castle Rock	141 36 30.00	321 26 47.00	4.4640921

SHEEP RANCH, BUTTE COUNTY.

In N. E. ¼ sec. 32, R. 3 E., T. 10 N., on the highest part of a flat hill overlooking Owl Creek. Hill is a spur from the divide between Owl and Indian creeks, but drainage from it all flows to Owl Creek, it forming a divide between Owl Creek and a small tributary of that creek. Station is 9 miles north and 4 miles east from the town of Belle Fourche. An old sheep ranch is about a mile southwest of station on the west or farther bank of Owl Creek.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post stamped "△", elevation 3107, and set 3 feet in the ground.

[Latitude 44° 47′ 31.89″. Longitude 103° 46′ 02.36″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	226 01 11	46 14 44	4.54470
Badlands	158 48 44	338 46 58	3.96060
Number 27	267 42 54	87 49 50	4.11368

SHYKET, BUTTE COUNTY.

In section 3, T. 8 N., R. 4 E., on a table-land between Belle Fourche River and Owl Creek, overlooking both those streams, and is on the southeast end of the ridge. Station is 3 miles north and 3 miles east of Snoma post-office.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post marked "△" and set 3 feet in the ground.

[Latitude 44° 41′ 15.19″. Longitude 103° 36′ 39.06″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Castle Rock	199 43 29	19 50 24	4.58169
Owl	246 59 18	67 15 53	4.52838
Number 18	146 24 18	326 21 53	3.91217
Twin	303 45 18	123 47 53	3.76576
May	89 19 02	269 17 32	3.45228
Horse	234 54 16.	54 57 37	3.88561
Snoma Butte	28 23 32	208 22 04	3.76355
Somerset	53 08 23	233 03 02	4.09942

SIMMONS, BUTTE COUNTY.

Station is in section 31, T. 8 N., R. 7 E., on a low hill, about 4 miles east and 1 mile south of Vale post-office, and is about 1 mile south and a little east of Esmond Simmons's house.

Signal: A lumber tripod, 12 feet high, with targets.

Station mark: An iron bench-mark post marked "△" and set 3 feet in the ground.

[Latitude 44° 36′ 23.06″. Longitude 103° 18′ 25.79″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wilson	125 59 48	305 56 39	3.86454
Fourmile	243 07 45	63 11 59	3.95116
B. M	232 36 08	52 39 20	3.88053
Vale Butte	66 38 46	246 34 59	3.89136

SUSIE PEAK, BUTTE COUNTY.

A small conical peak near the center of T. 9 N., R. 3 E., Black Hills meridian, situated on east end of a high ridge bearing southeast and northwest, being the divide between Crow and Owl creeks, about 6 miles northeast of the town of Belle Fourche and about 2 miles north of Belle Fourche River.

Station mark: A bronze triangulation tablet cemented in stone sunk flush with surface of ground.

[Latitude 44° 44′ 10.08″. Longitude 103° 44′ 13.75″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Terry	8 09 49.51	189 05 58.21	4.6616893
Crow Peak	30 34 32.16	210 25 19.14	4.5342997
Warren Peak	63 20 21.79	242 50 33.50	4.7991448
Wymonkota	138 34 02.37	318 19 33.87	4.6099751
Castle Rock	216 46 29.57	36 58 45.39	4.5814773
Deer Ears	236 18 10.00	56 41 49.00	4.72398
Owl Butte	259 10 20.70	79 32 16.68	4.6212654
Bear Butte	318 43 45.57	138 57 09.55	4.5838871
Northside	101 31 42.00	281 27 41.00	3.88631
Badlands	158 55 06.00	338 52 02.00	4.19875
Schoolhouse	219 03 36.00	39 07 22.00	4.04811
Number 27	237 31 36.00	57 37 16.00	4.09895
Shyket	298 17 53.00	118 23 14.00	4.05584
Somervault	0 09 21.00	180 09 30.00	4.11224

WILLOW, BUTTE COUNTY.

In section 24, T. 9 N., R. 6 E., on the divide between Willow and Dry creeks, overlooking Willow Creek, and about 1 mile northwest of Sheffield's ranch.

Station mark: An iron bench-mark post set 3 feet in the ground.

[Latitude 44° 43′ 41.02″. Longitude 103° 19′ 03.79″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Owl	222 25 14	42 29 27	4.06756
Dry	137 24 27	317 22 01	3.82937
Number 7	50 23 39	230 19 11	4.03653
Edwards	303 22 58	123 26 35	3.90986

WILSON, BUTTE COUNTY.

Station is in section 21, T. 8 N., R. 6 E., on top of a prominent hill about 600 yards south and west of the Wilson schoolhouse, and 1½ miles north and one-half mile east of Vale post-office.

Signal: A lumber tripod 12 feet high, with targets.

Station mark: An iron bench-mark post marked "△" and set 3 feet in the ground.

[Latitude 44° 38′ 42.35″. Longitude 103° 22′ 54.56″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Dry (2)	173 09 30	353 08 23	4.24295
Fourmile	271 02 01	91 09 24	4.14295
Simmons	305 56 39	125 59 48	3.86454
Number 7	124 41 04	304 39 19	3.60312
Vale Butte	9 22 18	189 21 39	3.87451

The following points were not occupied, but were located by intersections from two or more stations:

Name.	Latitude.	Longitude.
	° ′ ″	° ′ ″
B. M	44 38 52.41	103 13 51.97
Corner	44 45 50.70	103 38 31.72
Dry	44 46 21.98	103 22 31.57
Edwards	44 41 16.06	103 13 55.69
Hogback	44 45 00.44	103 12 56.30
Horse	44 43 38.22	103 31 53.34
Hough	44 42 18.10	103 23 23.10
May	44 41 14.08	103 38 47.70
Northside	44 44 50.76	103 49 56.58
Schoolhouse (chimney)	44 48 50.98	103 38 53.39
Number 7	44 39 56.23	103 25 24.21
Snoma Butte	44 38 29.82	103 38 44.23
Somervault	44 37 10.60	103 44 15.34
Tank	44 45 39.56	103 28 08.46
Twin	44 39 30.16	103 32 59.02
Vale Butte	44 34 42.93	103 23 49.83

The positions of the following section corners were determined by measuring the azimuth and distanee from an occupied triangulation station:

	Latitude.	Longitude.
	° ′ ″	° ′ ″
T. 8 N., R. 7 E., sec. 31, quarter corner south side of	44 36 19.33	103 18 35.86
T. 8 N., R. 7 E., sec. 24, quarter corner north side of	44 38 54.90	103 12 31.02
T. 9 N., R. 5 E., sec. 32, southwest corner	44 41 29.41	103 32 25.12
Closing corner	44 41 29.41	103 32 28.05
T. 9 N., R. 5 E., sec. 25, northwest corner	44 43 13.31	103 27 33.33
T. 9 N., R. 6 E., sec. 24, quarter corner east side of	44 43 39.43	103 19 01.59
T. 9 N., R. 4 E., sec. 18, northeast corner of	44 44 58.71	103 39 44.25
T. 9 N., R. 5 E., sec. 11, quarter corner north side	44 45 49.82	103 28 09.87
T. 9 N., R. 5 E., sec. 8, northeast corner	44 45 49.85	103 31 12.76
T. 9 N., R. 7 E., sec. 5, quarter corner north side of	44 46 42.85	103 17 09.55
T. 10 N., R. 4 E., sec. 27, southeast corner	44 47 34.59	103 36 05.05
T. 10 N., R. 3 E., sec. 32, northeast corner	44 47 35.35	103 45 49.87
T. 10 N., R. 6 E., sec. 29, quarter corner north side of	44 48 26.57	103 24 29.40

TEXAS.

TRIANGULATION STATIONS.

EL PASO COUNTY.

VANHORN QUADRANGLE.

In the summer of 1904 Mr. Arthur Stiles, topographer, obtained additional control for the Vanhorn quadrangle by occupying two old stations, Chispa and Diablo, and two new stations, Delaware and 7: Heart, from which he located numerous secondary points, by intersections.

Positions are based upon the Sierra Blanca base and astronomic station.

ALLAMOORE, EL PASO COUNTY.

(Not occupied.)

The highest peak in the mountains 1 mile southwest of Allamoore section house and 10 miles west of Vanhorn. Pack animals can be taken to the station from Allamoore. Permanent water in Texas and Pacific Railroad water tank 2 miles west of Allamoore.

Station mark: A bronze triangulation tablet cemented in solid rock under center of rock monument 6 feet high.

Reference marks: A cross mark and the letters "U. S." cut deep in the rock bears N. 14° 00′ E., distant 3.8 feet. Another cross mark cut in the rock bears S. 69° 15′ E., distant 20.6 feet.

[Latitude 31° 03′ 17.0″. Longitude 104° 58′ 46.3″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Delaware			4.7672985
Diablo			4.2301358
7: Heart			4.7405816

BAYLER, EL PASO COUNTY.

(Not occupied.)

On the highest point in the north end of the Bayler Mountains, about 16 miles north of Vanhorn, and 4 miles southwest of Marley's lower windmills. Pack animals can be taken to the station from northeast side of mountain. Water at lower windmills.

Station mark: The center of a rock monument 6 feet in diameter and 5 feet high.

Reference marks: A bronze triangulation tablet cemented in the solid rock bears N. 18° 00′ W., distant 31.2 feet. A cross mark and the letters "U. S." cut deep in the solid rock bears N. 76° 00′ W., distant 22 feet.

[Latitude 31° 14′ 32.06″. Longitude 104° 45′ 52.42″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
7:Heart	....	....	4.5101987
Delaware	....	....	4.4784373
Diablo	....	....	4.1799165

CHISPA, JEFF DAVIS COUNTY.

Near El Paso County line, on the highest of the peaks, about 4 miles northwest of Chispa and 3 miles north of Williams's ranch. A wagon can be driven up the main draw from Williams's ranch to bottom of the peak on the south side, and pack animals can go from this point to within 200 feet of station. Nearest water is at Williams's ranch.

Station mark: A cross mark cut deep in a large stone over which is centered a large rock monument.

Reference marks: A bronze triangulation tablet cemented in the solid rock 9.3 feet distant; true azimuth, 129° 35′. A cross mark and the letters "U. S." cut deep in the rock, 10.8 feet distant; true azimuth, 359° 15′.

[Latitude 30° 48′ 07.73″. Longitude 104° 42′ 36.10″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Diablo	156 01 31.3	335 55 12.1	4.6810032
Delaware	186 07 00.7	6 09 39.8	4.8820127
7:Heart	211 15 38.0	31 24 20.5	4.7139576

DIABLO, EL PASO COUNTY.

On the highest south part of the Sierra Diablo, about 14 miles northwest from Vanhorn, about 12 miles northwest of Allamoore and 2 miles north of the Hazel mine. Pack animals can be taken to station from the main canyon on southwest side by following a dim road from point 1.5 miles west of Hazel mine up canyon to a small spring; thence up a cow trail and old log trail on east side ot canyon to top of ridge which projects southward from the station. Nearest water is in small spring.

Station mark: A bronze triangulation tablet cemented in solid rock over which is built a rock monument 8 feet high.

Reference marks: A cross mark and the letters "U. S." cut deep in the rock 10.6 feet distant; true azimuth, 76° 43′. Another cross mark cut in the rock 16.5 feet distant; true azimuth, 219° 43′.

[Latitude 31° 11′ 50.54″. Longitude 104° 54′ 52.40″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Delaware	220 44 16.0	40 53 19.0	4.6255468
7: Heart	269 23 26.9	89 38 33.9	4.6660690
Chispa	335 55 12.13	156 01 31.25	4.6810032

JOE MARLEY, EL PASO COUNTY.

(Not occupied.)

On a high, round-topped mesa in the southern end of the Delaware mountains, about 25 miles northeast of Vanhorn, and about 6 miles east of Ed Jones's ranch. Pack animals can be taken to the station from a point on the Toyah and Salt Flat road, about 1 mile east of the 7:Heart gap, at which point road passes 1.5 miles north of station. Water in a tank on the main Toyah road, 8 miles northwest of station, or at Ed Jones's ranch.

Station mark: A bronze triangulation tablet cemented in the solid rock, over which is built a pile of rocks and cedar brush 4 feet high.

Reference marks: A cross mark and letters "U. S." cut deep in solid rock bears S. 79° 30′ W., distant 12 feet. Another cross mark cut in rock bears N. 40° 30′ W., distant 8.5 feet.

[Latitude 31° 12′ 53.24″. Longitude 104° 29′ 58.81.″]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
7:Heart	....	....	3.8438983
Delaware	....	....	4.5091049
Chispa	....	....	4.6986507

MEDLEY'S WINDMILL, EL PASO COUNTY.

(Not occupied.)

On the flats, about 1.5 miles northeast of Wild Horse section house and about 8 miles east of Vanhorn. The largest and southernmost of Medley's two home-ranch windmills, about 500 feet south of his residence.

Station mark: Center of windmill tower.

No reference marks.

[Latitude 31° 03′ 55.1″. Longitude 104° 42′ 33.9″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
7 : Heart			4. 4877565
Delaware			4. 6748098
Diablo			4. 3880670

NORTH DIABLO, EL PASO COUNTY.

(Not occupied.)

On the highest point of the Sierra Diablo, on the bluffs overlooking the Salt Flat road and the Figure Two headquarters ranch. Thirty-five miles north of Vanhorn, 12 miles northeast of Bounds "Dagger Tank." A dim road leads from this tank to 0.5 mile south of station.

Station mark: A cross mark cut deep in the rock, over which is a pile of stone 2 feet high and a tree signal.

Reference marks: A bronze triangulation tablet cemented in the solid rock and bearing N. 59° 17′ W., distant 25.6 feet from station mark.

[Latitude 31° 26′ 51.7″. Longitude 104° 54′ 14.2″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Diablo			4. 4436025
Delaware			4. 4294808
7 : Heart			4. 7235100
Chispa			4. 8687802

7 : HEART, EL PASO COUNTY.

About 35 miles northeast of Vanhorn and 10 miles north of Boracho. On the highest point of the long bluffs overlooking Toyah and all the country northeast. About 5 miles southeast of 7 : Heart Gap and 5 miles from Joe Shea's ranch. Pack animals can be taken to the station from the old Salt road which passes just beneath it on north side. Permanent water at Joe Shea's ranch or Ed Jones's ranch.

Station mark: A bronze triangulation tablet cemented in the solid rock, over the exact center of which is built a rock monument 8 feet high.

Reference marks: A cross mark and the letters "U. S." cut deep in the solid rock bears northeast 14.1 feet; true azimuth, 249° 24′. Another cross mark in the rock bears northwest 10.6 feet; true azimuth, 130° 22′.

[Latitude 31° 12′ 03.26″. Longitude 104° 25′ 41.61″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chispa	31 24 20.5	211 15 38.0	4.7139576
Diablo	89 38 33.9	269 23 26.9	4.6660690
Delaware	149 25 47.5	329 19 39.8	4.5644395

DELAWARE, EL PASO COUNTY.

On the highest peak of the Delaware Mountains, about 14 miles due east of the Figure Two headquarters ranch, 40 miles northeast of Vanhorn, and 15 miles northwest of Luckett's ranch. Pack animals can easily be taken to the station by following up the smooth ridge from the big tank which lies 7 miles due east. A good wagon road leads from Vanhorn by way of Aden's old dugouts to Aden's dry well, thence north about 1.25 miles to the tank. Nearest water is in tank or at the dugout or in John Well in Salt Flat, about 5 miles west of station.

Station mark: A bronze tablet cemented in the solid rock 3 inches under the surface of the ground, over which is a pile of rocks and cedar brush 5 feet high.

Reference marks: A cross mark and the letters "U. S." cut deep in the rock bears southwest 10.7 feet; true azimuth, 22° 36′. Another cross mark cut in the rock bears northwest 13 feet; true azimuth, 99° 33′.

[Latitude 31° 29′ 08.20″. Longitude 104° 37′ 28.40″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chispa	6 09 39.8	186 07 00.7	4.8820127
Diablo	40 53 19.0	220 44 16.0	4.6255468
7: Heart	329 19 39.8	149 25 47.5	4.5644395

SQUARE MESA, EL PASO COUNTY.

(Not occupied.)

On a high, square-top, cap-rock mesa in the west side of the Delaware Mountains about 28 miles northeast of Vanhorn, 10 miles north of Bean's ranch, and 7 miles southeast of Freeman's well in Canon's pasture. Pack animals can be taken to station from north end of mesa. Water in Freeman's well.

Station mark: A bronze triangulation tablet cemented in the solid rock, over which is centered a rock monument 6 feet high.

Reference marks: A cross mark and the letters "U. S." cut deep in the rock bears S. 30° 35′ E., distant 6.4 feet. Another cross mark cut in the rock bears N. 25° 00′ E. from station mark, distant 9.0 feet.

[Latitude 31° 22′ 15.21″. Longitude 104° 37′ 50.93″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
7: Heart			4.4308612
Delaware			4.1049368
Diablo			4.5207042

PLATEAU, EL PASO COUNTY

(Not occupied.)

Sixteen and a half miles east of Vanhorn.

Station mark: Center of section house on north side of Texas and Pacific Railroad track.

Reference marks: None.

[Latitude 31° 03′ 45.9″. Longitude 104° 33′ 28.2″.]

To station—	Azimuth.	Back Azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
7: Heart			4.2941549
Delaware			4.6749697
Diablo			4.5699588

VANHORN, EL PASO COUNTY.

The steeple of the Presbyterian Church in the village of Vanhorn.

Station mark: Center of steeple above belfry.

[Latitude 31° 02′ 39.6″. Longitude 104° 50′ 05.8″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
7: Heart			4.6295681
Chispa			4.4643875
Delaware			4.7252920

WILD HORSE, EL PASO COUNTY.

(Not occupied.)

About 8 miles east of Vanhorn.

Station mark: Center of section house on north side of Texas and Pacific Railroad track.

[Latitude 31° 03′ 04.2″. Longitude 104° 41′ 53.3″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
7: Heart			4. 4861950
Delaware			4. 6872816
Diablo			4. 4190261

WYLIE MOUNTAIN, EL PASO COUNTY.

(Not occupied.)

The highest point on the southwest rim of the Wylie Mountains, about 7 miles southeast of Vanhorn and 6 miles southwest of Wild Horse section house. Pack animals can be taken to station from either place.

Station mark: Center of a rock monument 5 feet high.

Reference marks: A triangulation tablet cemented in the solid rock bears S. 41° 32′ E., distant 29.4 feet. A cross mark and the letters "U. S." cut deep in the rock bears N. 35° 30′ W., distant 9 feet.

[Latitude 30° 58′ 38″.0. Longitude 104° 44′ 58.5″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
7: Heart			4. 5959053
Diablo			4. 4630561

WYOMING.

TRIANGULATION STATIONS.

BIG HORN AND FREMONT COUNTIES.

KIRWIN AND OTHER QUADRANGLES.

During the season of 1904 Mr. R. B. Robertson, field assistant, extended triangulation from the stations Wise, Franks, and Squaw, previously located from Ranchester base and the Sheridan and Yellowstone Lake mean astronomic position eastward, connecting with

stations Warner, Antelope, and Hyatt, established from the same base.

During the progress of this work 23 new and 6 old stations were occupied, and 14 points were located by intersection.

ANTELOPE, BIGHORN COUNTY.

On the highest of the grassy hills between Ten Sleep and Broken Back creeks; 2 miles east of a small sawmill on the Dry Fork of Broken Back Creek, 4 miles east of "Pole Patch" and 15 miles northeast of Ten Sleep post-office. Road from Ten Sleep post-office and "Pole Patch" following up Broken Back Creek passes 1 mile west of station, and when road first gets on the divide between Broken Back and Ten Sleep creeks, it is about 1 mile north of signal.

Station mark: Copper bolt cemented into a limestone rock, over which is centered a rock monument.

[Latitude 44° 10′ 25.16″. Longitude 107° 16′ 38.77″.] [a]
[Latitude 44° 10′ 25.06″. Longitude 107° 16′ 38.44″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Warner	30 32 23.69	210 26 05.45	4.3773785
	[a] 30 32 00.46	210 25 42.28	4.3773627
Devil	40 52 18.43	220 39 58.73	4.5595237
Hyatt	95 43 31.90	275 29 22.27	4.4346483
	[a] 95 43 15.02	275 29 05.35	4.4346392
Number 1	335 50 42.41	155 58 12.50	4.5482649

[a] From Ranchester base via Cloud Peak.

BADLAND, BIGHORN COUNTY.

(Not occupied.)

On Badland Peak, a sharp peak on the divide between Nowater and Nowood creeks, the only peak of any consequence between Devil and Honeycomb triangulation stations and on same divide. Can be best reached from Nowood side.

Station mark: A very small pile of stone on summit of peak.

[Latitude 43° 51′ 35.73″. Longitude 107° 33′ 26.67″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Devil	170 27 43.98	350 27 05.39	3.8745949
Warner	215 52 08.84	35 57 31.09	4.2471630

BANNON, BIGHORN COUNTY.

(Not occupied.)

On the highest point of a north and soutn rock ridge about 5 miles southwest of Meeteetse.

Station mark: A large rock monument.

[Latitude 44° 05′ 53.00″. Longitude 108° 52′ 43.40″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Wise	142 29 04.14	322 21 51.22	4.3546505
Squaw	266 44 26.66	86 57 07.40	4.3864629

BIGHORN, BIGHORN COUNTY.

About 10 miles from Thermopolis on the most prominent peak of the main ridge on the north side of Kirby Creek, 3 miles from it and 2 miles from Bighorn River. Covered with cedar and pine. From Thermopolis take Casper road to Kirby Creek, then road down river 4 miles; a wood road goes halfway up peak, and there is a dim trail to summit. Easily reached from north side.

Station mark: A bronze triangulation tablet cemented in solid rock under a cairn 7 feet high.

[Latitude 43° 47′ 42.39″. Longitude 108° 06′ 35.75″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Canyon	10 12 32.05	190 09 05.92	4.5785696
Red	44 08 47.34	223 59 14.14	4.4265685
Padlock	81 03 10.92	260 46 43.28	4.5096836
Grass	104 52 24.78	284 33 01.42	4.5887724
Squaw	133 18 31.42	312 59 09.26	4.7090854
Olwen	184 07 23.77	4 08 16.94	4.3757933
Honeycomb	272 26 59.03	92 46 50.79	4.5860154
Kirby	332 47 17.09	152 51 28.76	4.2514928

BLACK MOUNTAIN, BIGHORN COUNTY.

(Not occupied.)

A well-known point at head of south fork of Nowater Creek and near head of Lake Creek, a tributary of Kirby Creek.

[Latitude 43° 38′ 42.58″. Longitude 107° 42′ 11.45″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Deranch	16 21 36.79	196 20 19.69	3.9496860
Kirby	91 55 52.05	271 43 12.66	4.3921552

COTTONWOOD, BIGHORN COUNTY.

On a ridge slightly above timber line at the head of main fork of Cottonwood Creek. It is difficult to reach from the north and east, but it might be reached by taking road from Ilo post-office to sawmill high up on Grass Creek, thence along ridge between Gooseberry and Grass creeks. Also reached by road to head of Enos Creek, thence along ridge between Enos and Grass creeks.

Station mark: A bronze triangulation tablet cemented in rock, over which a cairn 7 feet high was erected.

[Latitude 43° 49′ 18.39″. Longitude 109° 03′ 46.88″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Muddy	32 41 13.69	212 35 40.93	4.3002287
Wiggins	90 01 54.07	269 47 10.42	4.4551263
Franks	125 18 40.68	305 07 14.99	4.4316966
Wise	181 06 18.81	1 06 48.21	4.6870035
Squaw	230 32 33.06	50 52 52.56	4.7040942
Grass	259 50 35.74	80 10 49.21	4.5990271
Putney	277 12 53.62	97 26 28.40	4.4236815
Owl	310 52 39.29	131 07 33.64	4.5843002

CROSBY, BIGHORN COUNTY.

On a high, shell-rock peak at head of Horse Creek of Wood River and a branch of Grey Bull River, about 1.5 miles from Kirwin. Station may be reached by trail from Kirwin; also a trail up Horse Creek and an open ridge from the head of creek to station.

Station mark: A stone set in ground level with surface and marked
"U. S.
△ over which a cairn of rock 7 feet high was erected.
G. S."

[Latitude 43° 52′ 40.01″. Longitude 109° 19′ 55.07″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Wiggins	47 41 43.82	227 38 10.44	3.9688235
Peak	115 45 29.23	295 38 00.43	4.2048098
Franks	177 09 13.30	357 08 58.82	3.9717717

DERANCH, BIGHORN COUNTY.

On the most prominent peak on Lyesite Mountain at the head of Lake Creek, a tributary of Kirby Creek. Road goes up one fork of Bridger Creek almost to station. Deranch post-office is about 7 miles south of station. Peak is timbered on the Lake Creek side and smooth and grassy on the Bridger Creek side. Water in both creeks.

Signal: A rock cairn 8 feet high built around a small pine tree.

Station mark: A bronze triangulation tablet set in stone which was placed in ground under center of signal.

[Latitude 43° 34′ 05.67″. Longitude 107° 44′ 03.23″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	Meters.
Canyon	72 06 05.85	251 47 08.90	4.5911836
Kirby	112 55 33.71	292 44 11.96	4.3811117
Honeycomb	199 25 15.59	19 29 28.37	4.3956133
Mahogany	254 14 08.07	74 29 11.35	4.4843181

DEVIL, BIGHORN COUNTY.

On Devil Peak, a conspicuous peak about 10 miles southwest of Ten Sleep post-office, near the head of the north fork of Nowater Creek, on the divide between Nowater Creek and Nowood Creek, and on the eastern edge of the badlands known as the Honeycomb, at the head of Little Cottonwood Creek. Can be reached best from Ten Sleep post-office by going south along road for 7 or 8 miles until road bears east, thence across country in a southwest direction. No attempt should be made to approach station from south, west, or north, but only from Nowood Creek above Ten Sleep post-office.

Station mark: A bronze tablet set in stone embedded in ground level with surface, over which a small pole tripod was centered. A few stones were piled over station mark, one of which was marked "U. S.
△
G. S."

[Latitue 43° 55′ 35.12″. Longitude 107° 34′ 22.32″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Honeycomb	16 06 47.67	196 04 21.36	4.2308524
Olwen	102 35 07.14	282 13 38.09	4.6271725
Hyatt	173 28 37.12	353 26 49.24	4.4817734
Antelope	220 39 58.73	40 52 18.43	4.5595237
Warner	239 07 34.04	59 13 35.11	4.1305128
Number 1	276 59 18.33	97 19 05.30	4.5854240

ENOS, BIGHORN COUNTY.

(Not occupied.)

A double-topped foothill, well timbered, especially on north side, situated at the head of Enos Creek; a tributary of Gooseberry Creek and Elk Creek, also head near station. There is a road from Ilo post-office to a sawmill 2 miles south of station, also a road from Dickey's ranch to the head of Enos Creek and a trail from there to station.

Signal: A tripod made of poles.

Station mark: A bronze triangulation tablet set in stone which was sunk in ground under center of signal.

[Latitude 43° 53′ 32.89″. Longitude 108° 57′ 30.10″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wise	169 41 13.12	349 37 20.42	4.6175365
Squaw	231 40 40.45	51 56 38.98	4.5923247

FLAGSTAFF, BIGHORN COUNTY.

(Not occupied.)

On a flat-topped hill known as Monument Hill about 1 mile north of and visible from the town of Thermopolis and overlooking the cemetery. There has been a monument or cairn on the summit of hill, but the point located was a flagstaff wedged in crevice of rock at edge of bluff toward Thermopolis.

[Latitude 43° 39′ 43.15″. Longitude 108° 13′ 05.55″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Kirby	273 36 05.48	93 44 46.00	4.2286798
Canyon	354 47 50.89	174 48 53.56	4.3541277

GRASS, BIGHORN COUNTY.

On a peak of the dividing ridge between Cottonwood and Grass creeks and about 3 miles southwest of Ilo post-office, from which the signal is visible. Take road up Grass Creek for 1.5 miles, then a good ridge to the left heading toward the highest point in sight.

Signal: A small pine tree set 2 feet in ground and braced with cedar posts.

Station mark: In ground under center of top of tree or where braces meet, not where tree goes in the ground.

Reference mark: A bronze triangulation tablet set in large bowlder placed in ground centered under eccentric position of instrument, 5.1 feet north of tree.

[Latitude 43° 53′ 01.61″. Longitude 108° 34′ 35.36″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Putney	51 22 49.16	231 16 11.28	4.2158835
Cottonwood	80 10 49.21	259 50 35.74	4.5990271
Squaw	180 15 18.81	0 15 22.42	4.4004984
Bighorn	284 33 01.42	104 52 24.78	4.5887724
Padlock	339 20 51.88	159 23 46.31	4.2036418

HONEYCOMB, BIGHORN COUNTY.

On the highest point of a grassy ridge at the upper end of a divide between two of the main prongs of Nowater Creek, and at the southeast edge of the Honeycombs. Station is within a mile of divide between Nowater and Nowood creeks; about 7 miles north 4° east from Hartman's cabin on Nowater. Water at Minnick's cabin 1.5 miles above Hartman's. Take Black Mountain road from Nowood.

Signal: A tripod 7 feet high made of cedar posts.

Station mark: A bronze triangulation tablet cemented in stone placed in ground under center of signal.

[Latitude 43° 46′ 45.39″. Longitude 107° 37′ 53.49″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Deranch	19 29 28.37	199 25 15.59	4.3956133
Kirby	65 13 37.82	244 58 01.77	4.5253072
Bighorn	92 46 50.79	272 26 59.02	4.5860154
Olwen	124 52 53.03	304 33 52.11	4.6501826
Devil	196 04 21.36	16 06 47.67	4.2308524
Warner	214 59 03.58	35 07 30.55	4.4537081

HYATT, BIGHORN COUNTY.

On the east end of a high prominent black ridge, divide between Paint Rock and Nowood creeks; about 5 miles south of Hyattsville. Spratt's ranch road passes in a low gap about 0.5 miles east of station. This road branches south from Hyattsville.

Station mark: A copper bolt cemented into a river bowlder, which is buried flush with ground over which is a small pile of slate rock.

[Latitude 44° 11′ 51.18″. Longitude 107° 36′ 57.44″.]
[Latitude 44° 11′ 51.18″. Longitude 107° 36′ 57.76″.[a]]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Olwen	61 06 59.31	240 47 15.06	4.6364139
Antelope	275 29 22.27	95 43 31.90	4.4346483
	[a] 275 29 05.35	95 43 15.02	4.4346392
Warner	327 01 02.83	147 08 52.73	4.4415953
	[a] 327 00 40.96	147 08 30.98	4.4415938
Devil	353 26 49.24	173 28 37.12	4.4817734

[a] From Ranchester base via Cloud Peak.

KIRBY, BIGHORN COUNTY.

On a prominent peak at the head of a small creek which joins the Bighorn River btween Thermopolis and Bighorn Hot Springs. Station is about 5 miles from Kirby Creek and 9 miles east of Thermopolis. Follow road east 5 miles from Bighorn bridge until one-half mile beyond where water is crossed and take trail up main gulch.

Station mark: A bronze triangulation tablet cemented in rock under a cairn 8 feet high.

[Latitude 43° 39′ 08.04″. Longitude 108° 00′ 31.64″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Canyon	34 50 35.25	214 42 58.50	4.4163571
Red	83 03 19.33	262 49 35.61	4.4307262
Bighorn	152 51 28.75	322 47 17.08	4.2514928
Honeycomb	244 58 01.77	65 13 37.82	4.5253072
Deranch	292 44 11.96	112 55 33.72	4.3811117

MAHOGANY, BIGHORN COUNTY.

On the highest point of Mahogany Butte, a prominent spur from the main mountain forming a perpendicular bluff on the side of Nowood Creek; about 5 miles down the creek from Nowood post-office. Road from Nowood to Redbank and Big Trails passes directly under station. Take this road from Nowood post-office to a point where it crosses a creek on a bridge, then take trail to right.

Station mark: A bronze triangulation tablet cemented in solid rock, over which a cairn 8 feet high is centered.

[Latitude 43° 38′ 32.10″. Longitude 107° 22′ 13.57″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Deranch	74 29 11.34	254 14 08.07	4.4843181
Honeycomb	125 58 26.19	305 47 36.38	4.4145173

NEEDLES, BIGHORN COUNTY.

(Not occupied.)

"Washakie Needles," a well-known high rocky peak at the head of Owl Creek, near the farthest north corner of Shoshone Reservation. Probably best reached from head of South Owl Creek. This is the most prominent point in the Shoshone Range.

[Latitude 43° 44′ 53.63″. Longitude 109° 12′ 01.80″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Cottonwood	233 30 37.52	53 36 20.00	4.13854
Muddy	357 57 10.48	177 57 20.00	3.93671

NUMBER 1, NEAR LINE OF BIGHORN AND JOHNSON COUNTIES.

On a rocky point of the Bighorn and Powder River divide, at the head of Otter Creek, a tributary of the Bighorns, and of Red Fork of Powder River. Station is 1.5 miles north of Young Brothers' sheep-dipping vats and 0.25 mile northwest of wagon road which runs along top of divide.

Station mark: A cairn 5 feet high.

Reference mark: A bronze tablet cemented in solid rock centered under eccentric position of instrument, 4.6 feet distant from station.

[Latitude 43° 52′ 59.79″. Longitude 107° 05′ 50.63″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Devil	97 19 05.30	276 59 18.32	4.5854240
Antelope	155 58 12.50	335 50 42.40	4.5482649

NUMBER 2, ON LINE BETWEEN BIGHORN AND JOHNSON COUNTIES.

(Not occupied.)

Very close to divide between Bighorn and Powder rivers, and probably in Bighorn County. Cahoots prospect cabin is about a mile southwest. A road from Helman ranch near Bigtrails post-office passes under this ridge, and cairn is visible from the road for several miles west.

Station mark: A cairn 10 feet high.

[Latitude 43° 46′ 05.83″. Longitude 107° 07′ 57.83″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Devil	116 33 18.20	296 15 00.62	4.5967291
Warner	135 58 16.02	315 45 58.39	4.5330259

OLWEN, BIGHORN COUNTY.

On a flat ridge about 5 miles west of Worland post-office and same distance north of Olwen post-office. On the dividing ridge between Gooseberry and Fifteen Mile creeks. There is a double round hill about 0.75 mile southwest of station.

Signal: A tripod made of cottonwood poles.

Station mark: A bronze triangulation tablet cemented in a rock buried in ground, level with surface, over which were placed a few round stones.

[Latitude 44° 00′ 30.13″. Longitude 108° 05′ 19.07″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bighorn	4 08 16.93	184 07 23.76	4.3757933
Padlock	49 31 50.27	229 14 27.55	4.6458453
Squaw	106 20 30.32	286 00 12.59	4.6083708
Hyatt	240 47 15.06	61 06 59.31	4.6364139
Devil	282 13 38.09	102 35 07.14	4.6271725
Honeycomb	304 33 52.11	124 52 53.03	4.6501826

PADLOCK, BIGHORN COUNTY.

On the divide between Cottonwood and Owl creeks, about 2.5 miles northeast of the Padlock ranch, which is about 17 miles from Thermopolis and 12 miles from Embar, and just across Owl Creek from the road between Thermopolis and Embar.

Station mark: A bronze triangulation tablet cemented in solid rock under a cairn 8 feet high.

[Latitude 43° 44′ 56.97″. Longitude 108° 30′ 23.42″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Owl	42 55 22.94	222 47 13.24	4.3684450
Putney	104 18 06.60	284 08 34.91	4.2803062
Grass	159 23 46.31	339 20 51.88	4.2036418
Squaw	172 12 15.64	352 09 24.45	4.6072575
Olwen	229 14 27.55	49 31 50.27	4.6458453
Bighorn	260 46 43.28	81 03 10.93	4.5096836
Red	316 22 14.77	136 29 07.91	4.2886167

PEAK ON LINE BETWEEN BIGHORN AND FREMONT COUNTIES.

On a sharp peak on the divide between Grey Bull and Wind River at the head of the middle branch of Wiggins Fork of Wind River, about 11 miles (air line) north 67° west from Kirwin post-office. Station can best be reached from Wiggins Fork.

Station mark: A bronze tablet set in soft rock of which top of hill is composed, over which cairn 7 feet high was erected.

Reference mark: A sharp column of yellow rock, true azimuth, 262° 24′, distant 300 feet; a rock in place in hillside facing signal marked "R. △ P.," true azimuth, 304° 03′, distant 45.6 feet.

[Latitude 43° 56′ 25.14″. Longitude 109° 30′ 42.21″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Round	49 17 20.19	229 07 12.17	4.4129986
Franks	260 08 45.46	80 16 00.12	4.1514187
Crosby	295 38 00.43	115 45 29.23	4.2048098
Wiggins	330 09 42.97	150 13 38.04	4.1827389

PUTNEY, BIGHORN COUNTY.

On a foothill 2 miles north of Cottonwood Creek and about 3 miles northeast of Veed Putney's ranch, at the Cottonwood Creek crossing of the Meeteetse-Embar road. Take road down Cottonwood Creek about a mile, then take trail north.

Station mark: A bronze triangulation tablet cemented in rock placed in ground under center of a cairn 8 feet high.

[Latitude 43° 47′ 28.76″. Longitude 108° 44′ 09.84″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Cottonwood	97 26 28.40	277 12 53.62	4.4236815
Grass	231 16 11.28	51 22 49.16	4.2158835
Owl	353 07 24.64	173 08 45.63	4.3417487
Spar	51 46 57.56	231 36 20.86	4.4196386
Muddy	70 16 13.00	249 57 06.67	4.5962388

RAMSHORN, FREMONT COUNTY.

(Not occupied.)

A very prominent, well-known jagged peak at the head of Little Horse Creek and probably on dividing ridge between Horse Creek and Del Noir River.

[Latitude 43° 43′ 22.60″. Longitude 109° 43′ 32.56″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wiggins	246 06 41.26	66 19 28.80	4.4332391
Coulee	298 26 09.20	118 43 18.71	4.5806452

RICHARDS, BIGHORN COUNTY.

On a prominent peak at the source of two main forks of West Kirby Creek, about 5 miles nearly south of Richards' ranch on West Kirby Creek. The peak is very conspicuous and shows against the sky line in most directions, although a rock ridge of probably higher altitude lies a mile or so to the south.

Signal: A cairn 5 feet high built around a small tree.

Station mark: A bronze tablet in soft concrete 2 feet under ground.

[Latitude 43° 29′ 29.59″. Longitude 107° 54′ 12.92″.]

To station—	Asimuth.	Back asimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Canyon	81 25 34.81	261 13 38.15	4.3743964
Kirby	154 34 48.08	334 30 27.04	4.2960484

SPAR, BIGHORN COUNTY.

On the most eastern bare point of a ridge forming the divide between South Owl Creek and one of its small tributaries, about 1.5 miles north of South Owl Creek Canyon. Station is about 3 miles a little west of south of an old sawmill location on road from Embar post-office to the head of South Owl Creek and about 3 miles southeast of the highest point on this road. By going up a ridge to the south of this high point in road and thence east along summit of ridge the station may be easily reached.

Station mark: A bronze tablet set in solid rock over which a tripod of poles was erected.

[Latitude 43° 38′ 40.92″. Longitude 108° 59′ 31.10″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Cottonwood	163 48 06.18	343 45 09.36	4.3115353
Putney	231 36 20.86	51 46 57.56	4.4196386

SQUAW, BIGHORN COUNTY.

The larger or western of two buttes, locally known as "Squaw Teats," in the badlands near the head of Fifteen Mile Creek. A round-up road leaves the settlement on the Grey Bull near Charles Dodge's ranch and goes up Long Hollow to the head of a branch of Fifteen Mile Creek, and then down that creek to the springs.

Station mark: Copper bolt sunk into a large bowlder under a rock monument.

Reference mark: "U. S. + G. S." chiseled on rock 13.20 feet south of station.

[Latitude 44° 06′ 36.39″. Longitude 108° 34′ 30.32″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Grass	0 15 22.42	180 15 18.81	4.4004984
Cottonwood	50 52 52.56	230 32 33.06	4.7040942
Franks Peak	75 12 00.96	254 40 12.39	4.8014691
Marquette	108 26 49.24	287 58 11.09	4.7605901
Wise	113 42 57.94	293 23 03.10	4.6184007
Elk	134 25 31.15	314 10 57.01	4.5894892
Fenton	172 54 28.31	352 53 20.08	4.2451364
Tatman	201 48 32.91	21 53 08.97	4.3732480
Dorsey	245 56 32.04	66 10 29.43	4.4656453
Olwen	286 00 12.59	106 20 30.32	4.6083708
Bighorn	312 59 09.25	133 18 31.41	4.7090854
Padlock	352 09 24.45	172 12 15.64	4.6072575

FRANKS PEAK, BIGHORN COUNTY.

The highest peak on the divide between Grey Bull and Wood rivers, at the head of Wiggins (or Jack) and Franks creeks. About 12 miles southwest from Colonel Pickett's ranch on the Grey Bull Valley to the Chicago tunnel at the foot of peak on the head of Wiggins Creek; the best way, and the one used by the mine people, starts in at Anderson's ranch and goes up Wiggins Creek.

Station mark: Copper bolt sunk into a large stone centered under a rock monument.

[Latitude 43° 57′ 43.25″. Longitude 109° 20′ 15.94″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wiggin	22 19 43.65	202 16 24.56	4.2276430
Peak	80 16 00.12	260 08 45.46	4.1827389
Younts	93 17 24.58	272 55 26.74	4.6270432
Pickett	167 35 58.67	347 32 58.12	4.4287274
Marquette	190 14 40.64	10 17 56.17	4.5443432
Wise	214 39 32.23	34 51 30.12	4.6045327
Squaw	254 40 12.39	75 12 00.96	4.8014691
Cottonwood	305 07 14.99	125 18 40.68	4.4316966
Crosby	357 08 58.82	177 09 13.30	3.9717717

WISE, BIGHORN COUNTY.

On a small hill on the Meeteetse River, about 8 miles south of Frost ranch on Stage Creek, 4 miles north of Wise post-office on Meeteetse Creek, about 500 feet east of Meeteetse-Red Lodge stage road and about one-fourth mile northeast of intersection of that road with a road leading to a sawmill on Meeteetse Creek.

Station mark: Copper bolt sunk in solid rock, over which is centered a large rock monument.

[Latitude 44° 15′ 34.05″. Longitude 109° 03′ 04.59″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Cottonwood	1 06 48.21	181 06 18.81	4.6870035
Franks Peak	34 51 30.12	214 39 32.23	4.6045327
Marquette	94 55 01.44	274 46 17.59	4.2228535
Cedar	160 21 21.38	340 16 26.88	4.4420796
Elk	224 03 33.58	44 08 55.72	4.1669415
Fenton	268 28 38.59	88 47 26.80	4.5546437
Squaw	293 23 03.10	113 42 57.94	4.6184007

THERMOPOLIS, BIGHORN COUNTY.

(Not occupied.)

A conspicuous low peak, covered with cedar brush, causing it to appear black, situated about 3 miles east of the town of Thermopolis. The peak is visible from the town, and lies slightly south of the line of Main street projected.

Station mark: An aluminum bench-mark tablet cemented in solid rock, over which a pole tripod was erected.

[Latitude 43° 38′ 37.58″. Longitude 108° 08′ 56.39″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Canyon	9 50 44.56	189 48 55.62	4.3177988
Kirby	265 11 43.40	85 17 31.84	4.0550435

WARNER, BIGHORN COUNTY.

On highest hill with scrub cedar on north slope 1 mile west of Nowood Creek, 3 miles south of junction of Nowood and Ten Sleep creeks. Two miles south of Mark H. Warner ranch on Nowood Creek.

Station mark: A copper bolt cemented into a large sandstone over which is centered a 6-foot rock monument.

[Latitude 43° 59′ 19.39″. Longitude 107° 25′ 42.35″.[a]]
[Latitude 43° 59′ 19.33″. Longitude 107° 25′ 42.14″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Devil	59 13 35.11	239 07 34.04	4.1305128
Hyatt	147 08 52.73	327 01 02.83	4.4415953
	[a] 147 08 30.98	327 00 40.96	4.4415935
Antelope No. 2	210 26 05.45	30 32 23.69	4.3773787
	[a] 210 25 42.28	30 32 00.46	4.3773627

[a] From Ranchester base via Cloud Peak.

CANYON, FREMONT COUNTY.

In the Wind River or Shoshone River Indian Reservation; on a prominent grassy peak overlooking the Bighorn River, and forming the bluff to canyon on the west side of that river. This peak is between Muddy Creek on the south, Red Canyon on the north, and Bighorn River on the east, being the nearest point of Owl Creek range to river. Station bears S. 10° E., distant 13 miles from Thermopolis. Water at head of Red Canyon.

Station mark: Middle of trunk of live pine tree 9 feet above ground.

Reference mark: A bronze triangulation tablet cemented in a large bowlder, compass bearing from mark to signal N. 12° W., distant 18 feet.

[Latitude 43° 27′ 33.87″. Longitude 108° 11′ 34.50″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Bighorn	190 09 05.92	10 12 32.04	4.5785696
Kirby	214 42 58.50	34 50 35.25	4.4163571
Deranch	251 47 08.90	72 06 05.85	4.5911836

COULEE, FREMONT COUNTY.

On a sharp, rocky peak at the lower end of a spur from the divide between Crow Creek and Sand Coulee; not far from head of Sand Coulee and between that creek and a tributary to it. Peak is covered with timber toward the top and is easily reached from any side.

Station mark: A bronze tablet set in stone in place, over which a cairn 8 feet high was erected.

Reference marks: "R △ P" cut in two stones firm in ground, one distant 14.9 feet, and the other 15.2 feet from station mark.

[Latitude 43° 32′ 33.42″. Longitude 109° 18′ 40.81″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wind River	81 42 09.32	261 33 34.32	4.2296220
Round	125 33 20.14	305 14 56.08	4.6428727
Wiggin	163 40 09.89	343 35 45.83	4.4826008
Muddy	216 43 38.24	36 48 22.90	4.1892120

MUDDY, FREMONT COUNTY.

On the highest peak at the heads of Muddy Creek, South Fork of Owl Creek, and Crow Creek, 5 miles nearly due south of the Washakie Needles and across the south fork of Owl Creek from them. Wagon road from Embar post-office up South Owl Creek reaches to within a few miles of station. Wagon may also be taken up Crow Creek from the Wind River side to a point directly under the peak.

Station mark: A bronze tablet set in the soft rock, of which peak is composed and under center of cairn 7 feet high.

Reference marks: Bowlder marked "R △ P" 11.1 feet distant from signal; bowlder marked "R △ P" 30 feet distant from signal.

[Latitude 43° 40′ 13.71″. Longitude 109° 11′ 48.12″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Coulee	36 48 22.90	216 43 38.24	4.1892120
Wiggins	133 22 56.30	313 13 46.63	4.3881458
Cottonwood	212 35 40.93	32 41 13.68	4.3002287
Putney	249 57 06.67	70 16 13.00	4.5962388
Owl	281 43 16.98	102 03 42.10	4.6093288

OWL, FREMONT COUNTY.

In the Wind River or Shoshone River Indian Reservation, on the most prominent point of the Owl Creek Mountains, the divide between Muddy and Owl creeks, and at the head of Red Creek, a tributary of Owl Creek. There is a road from Embar post-office to the timber at the head of the east fork of the west or main fork of Red Creek. This road starts up the main Red Creek and goes about 7 miles, from the end of which the station is about 2 miles south, on the highest of several rocky points.

Station mark: A bronze tablet set in stone over which a cairn 7 feet high was erected.

Reference marks: "R + P" on solid rock, distant 23.5 feet from station; "R + P" on solid rock, distant 15.6 feet from station.

[Latitude 43° 35′ 42.13″. Longitude 108° 42′ 12.59″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Muddy	102 03 42.10	281 43 16.93	4.6093288
Cottonwood	131 07 33.63	310 52 39.29	4.5843002
Putney	173 08 45.63	353 07 24.64	4.3417487
Padlock	222 47 13.24	42 55 22.94	4.3684450
Red	263 57 05.91	84 12 07.60	4.4694565

RED, FREMONT COUNTY.

In the Wind River or Shoshone River Indian Reservation, on a prairie hill which slopes gradually to the northwest and has bluffs on the south and east sides. The hill is on the divide between Mud Creek and Red Canyon and is about 9 miles from Thermopolis by wagon road. The Thermopolis and Lander road passes about one-half mile south of station, and signal is visible from this road.

Station is about 2.5 miles north of Nostrum's ranch in Red Canyon.

Station mark: An aluminum bench-mark tablet wedged in crack in solid rock under center of a cairn 8 feet high.

[Latitude 43° 37′ 20.69″. Longitude 108° 20′ 25.28″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Owl	84 12 07.60	263 57 05.91	4.4694565
Padlock	136 29 07.91	316 22 14.77	4.2886167
Bighorn	223 59 14.13	44 08 47.33	4.4265685
Kirby	262 49 35.61	83 03 19.33	4.4307262

ROUND, FREMONT COUNTY.

On the highest part of a round hill on top of a high mesa forming the divide between Horse Creek and the Du Noir River, about 5 miles north 20° west from the Ramshorn Mountain.

Station mark: A bronze tablet set in a piece of red lava rock placed in ground over which a cairn 8 feet high was erected.

[Latitude 43° 47′ 17.23″. Longitude 109° 45′ 19.64″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Peak	229 07 12.17	49 17 20.19	4.4129986
Wiggins	262 08 51.96	82 22 54.06	4.4384404
Coulee	305 14 56.08	125 33 20.14	4.6428727

STEAMBOAT, FREMONT COUNTY.

(Not occupied.)

The farthest south of two rocky points on divide between Bear Creek and North Fork of Wind River. This is a very prominent point.

[Latitude 43° 43′ 39.88″. Longitude 109° 23′ 50.74″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wind River	24 51 49.06	204 46 47.00	4.36878
Coulee	339 38 01.05	159 41 35.00	4.30088

WIGGINS, FREMONT COUNTY.

On the summit of a sharp, white peak on the divide between Wiggins Fork and Bear Creek, both tributaries of the Wind River. Peak is about 8 miles from Kirwin post-office. Trail leads up Wood River nearly to source, crosses a low saddle about 3 miles above Kirwin on to the head of Bear Creek, follows down this creek to the first large branch coming in from the west, crosses this branch, and follows up ridge to station. Peak shows sharp and white and can not be mistaken.

Station mark: A bronze tablet in loose rock 1 foot under surface, over which is a stone, level with surface and marked

"U S
△
G S"

centered under a cairn 6 feet high.

Reference marks: 1. A stone level with surface marked "R△P elevation 12164," distant 10.9 feet from station. 2. A stone set firmly in the ground marked "R△P," distant 11.5 feet from station.

[Latitude 43° 49′ 16.91″. Longitude 109° 25′ 03.08″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Round	82 22 54.06	262 08 51.95	4.4384404
Peak	150 13 38.03	330 09 42.97	4.1827389
Franks Peak	202 16 24.56	22 19 43.65	4.2276430
Crosby	227 38 10.44	47 41 43.82	3.9688235
Cottonwood	269 47 10.42	90 01 54.06	4.4551263
Muddy	313 13 46.63	133 22 56.30	4.3881458
Coulee	343 35 45.83	163 40 09.89	4.4826008

WIND RIVER, FREMONT COUNTY.

On a sharp prairie peak at the Wind River side of a flat prairie ridge lying between and close to the junction of Wind River, Horse Creek, Wiggins Fork, and North Fork of Wind River. Station is about 5 miles down Wind River from Dubois post-office and about 2 miles north of Wind River, and can be easily reached from the stage road where it crosses Wiggins Fork.

Station mark: A bronze tablet cemented in stone in place over which a cairn 7 feet high was erected.

Reference marks: "R△P" cut in two firmly embedded stones, distant 8.6 feet and 30 feet from station.

[Latitude 43° 32′ 12.38″. Longitude 109° 31′ 08.51″.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Wiggins	194 28 58.28	14 33 10.28	4.4964534
Coulee	261 33 34.32	81 42 09.32	4.2296220

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PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Bulletin No. 276.]

The publications of the United States Geological Survey consist of (1) Annual Reports, (2) Monographs, (3) Professional Papers, (4) Bulletins, (5) Mineral Resources, (6) Water-Supply and Irrigation Papers, (7) Topographic Atlas of United States—folios and separate sheets thereof, (8) Geologic Atlas of United States—folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

Most of the above publications may be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they may be obtained, free of charge (except classes 2, 7, and 8), on application.
2. A certain number are allotted to every member of Congress, from whom they may be obtained, free of charge, on application.
3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they may be had at prices slightly above cost.
4. Copies of all Government publications are furnished to the principal public libraries in the large cities throughout the United States, where they may be consulted by those interested.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports. This paper is the forty-eighth in Series F, the complete list of which follows (all are bulletins thus far except Professional Paper 45):

SERIES F, GEOGRAPHY.

5. Dictionary of altitudes in United States, by Henry Gannett. 1884. 325 pp. (Out of stock; see Bulletin 160.)
6. Elevations in Dominion of Canada, by J. W. Spencer. 1884. 43 pp. (Out of stock.)
13. Boundaries of United States and of the several States and Territories, with historical sketch of territorial changes, by Henry Gannett. 1885. 135 pp. (Out of stock; see Bulletin 171.)
48. On form and position of sea level, by R. S. Woodward. 1888. 88 pp. (Out of stock.)
49. Latitudes and longitudes of certain points in Missouri, Kansas, and New Mexico, by R. S. Woodward. 1889. 133 pp.
50. Formulas and tables to facilitate the construction and use of maps, by R. S. Woodward. 1889. 124 pp. (Out of stock.)
70. Report on astronomical work of 1889 and 1890, by R. S. Woodward. 1890. 79 pp.
72. Altitudes between Lake Superior and Rocky Mountains, by Warren Upham. 1891. 229 pp.
76. Dictionary of altitudes in United States (second edition), by Henry Gannett. 1891. 393 pp. (Out of stock; see Bulletin 160.)
115. Geographic dictionary of Rhode Island, by Henry Gannett. 1894. 31 pp.
116. Geographic dictionary of Massachusetts, by Henry Gannett. 1894. 126 pp.
117. Geographic dictionary of Connecticut, by Henry Gannett. 1894. 67 pp.
118. Geographic dictionary of New Jersey, by Henry Gannett. 1894. 131 pp.
122. Results of primary triangulation, by Henry Gannett. 1894. 412 pp., 17 pls. (Out of stock.)
123. Dictionary of geographic positions, by Henry Gannett. 1895. 183 pp., 1 map. (Out of stock.)
154. Gazetteer of Kansas, by Henry Gannett. 1898. 246 pp., 6 pls.

160. Dictionary of altitudes in United States (third edition), by Henry Gannett. 1899. 775 pp. (Out of stock.)
166. Gazetteer of Utah, by Henry Gannett. 1900. 43 pp., 1 map.
169. Altitudes in Alaska, by Henry Gannett. 1900. 13 pp.
170. Survey of boundary line between Idaho and Montana from international boundary to crest of Bitterroot Mountains, by R. U. Goode. 1900. 67 pp., 14 pls.
171. Boundaries of United States and of the several States and Territories, with outline of history of all important changes of territory (second edition), by Henry Gannett. 1900. 142 pp., 53 pls. (Out of stock.)
174. Survey of northwestern boundary of United States, 1857-1861, by Marcus Baker. 1900. 78 pp., 1 pl.
175. Triangulation and spirit leveling in Indian Territory, by C. H. Fitch. 1900. 141 pp., 1 pl.
181. Results of primary triangulation and primary traverse, fiscal year 1900-1901, by H. M. Wilson, J. H. Renshawe, E. M. Douglas, and R. U. Goode. 1901. 240 pp., 1 map.
183. Gazetteer of Porto Rico, by Henry Gannett. 1901. 51 pp.
185. Results of spirit leveling, fiscal year 1900-1901, by H. M. Wilson, J. H. Renshawe, E. M. Douglas, and R. U. Goode. 1901. 219 pp.
187. Geographic dictionary of Alaska, by Marcus Baker. 1901. 446 pp. (Out of stock.)
190. Gazetteer of Texas, by Henry Gannett. 1902. 162 pp., 8 pls. (Out of stock.)
192. Gazetteer of Cuba, by Henry Gannett. 1902. 113 pp., 8 pls. (Out of stock.)
194. Northwest boundary of Texas, by Marcus Baker. 1902. 51 pp., 1 pl.
196. Topographic development of the Klamath Mountains, by J. S. Diller. 1902. 69 pp., 13 pls.
197. The origin of certain place names in the United States, by Henry Gannett. 1902. 280 pp. (Out of stock.)
201. Results of primary triangulation and primary traverse, fiscal year 1901-2, by H. M. Wilson, J. H. Renshawe, E. M. Douglas, and R. U. Goode. 1902. 164 pp., 1 pl.
214. Geographic tables and formulas, compiled by S. S. Gannett. 1903. 284 pp.
216. Results of primary triangulation and primary traverse, fiscal year 1902-3, by S. S. Gannett. 1903. 222 pp., 1 pl.
224 Gazetteer of Texas (second edition), by Henry Gannett. 1904. 177 pp., 7 pls.
226. Boundaries of the United States and of the several States and Territories, with an outline of the history of all important changes of territory (third edition), by Henry Gannett. 1904. 145 pp., 54 pls.
230. Gazetteer of Delaware, by Henry Gannett. 1904. 15 pp.
231. Gazetteer of Maryland, by Henry Gannett. 1904. 84 pp.
232. Gazetteer of Virginia, by Henry Gannett. 1904. 159 pp.
233. Gazetteer of West Virginia, by Henry Gannett. 1904. 164 pp.
234. Geographic tables and formulas (second edition), compiled by S. S. Gannett. 1904. 310 pp.
245. Results of primary triangulation and primary traverse, fiscal year 1902-3, by S. S. Gannett. 1904. 328 pp., 1 pl.
248. Gazetteer of Indian Territory, by Henry Gannett. 1904. 70 pp.
258. The origin of certain place names in the United States (second edition), by Henry Gannett. 1905. 334 pp.

Professional Paper 45. The geography and geology of Alaska, a summary of existing knowledge, by A. H. Brooks, with a section on climate, by Cleveland Abbe, jr., and a topographic map and description thereof, by R. U. Goode.

274. A dictionary of altitudes in the United States (fourth edition), compiled by Henry Gannett.
276. Results of primary triangulation and primary traverse, fiscal year 1904-5, by S. S. Gannett. 1905. 263 pp., 1 pl.

Correspondence should be addressed to

The Director,
United States Geological Survey,
Washington, D. C.

December, 1905.

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263, iii p. map. $23\frac{1}{2}^{cm}$. (*Its* Bulletin no. 276.)
Subject series: F, Geography, 48.
1. Geographical positions—U. S. I. Gannett, Samuel Stinson.

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no. 276. Results of primary triangulation and primary traverse, fiscal year 1904–5; by S. S. Gannett. 1905.

Reference.

U. S. Dept. of the Interior.

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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

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BY

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GOVERNMENT PRINTING OFFICE
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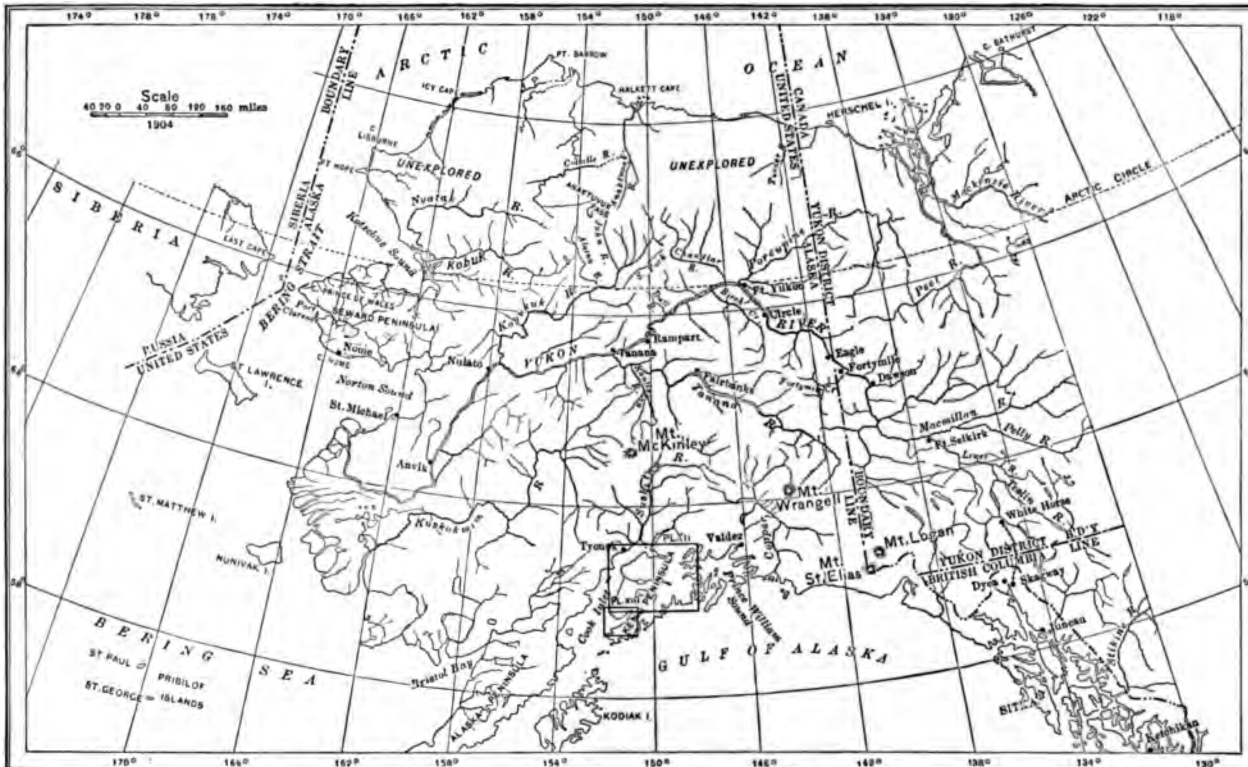

OUTLINE MAP OF ALASKA, SHOWING AREAS COVERED BY LARGER SCALE MAPS (PLS. II AND XIII).

MINERAL RESOURCES OF KENAI PENINSULA.

GOLD FIELDS OF THE TURNAGAIN ARM REGION.[a]

By Fred H. Moffit.

INTRODUCTION.

LOCATION AND AREA.

Kenai Peninsula (see Pls. I, II, and fig. 1) lies in the most northern portion of the great upward bend of that part of the Pacific coast line inclosing the Gulf of Alaska. It is about equally distant from the western extremity of the Alaska Peninsula and from Portland Canal, or it may be said to be midway between the ends of the bow. More accurately stated, all but a few square miles of the most northern part of Kenai Peninsula lies between meridians 148° and 152° west longitude and parallels 59° and 61° north latitude, its most southern point being a little more than 700 miles north of the boundary between the United States and Canada. The peninsula has an area of approximately 9,000 square miles. It is bounded by Cook Inlet on the west and Prince William Sound on the east and is nearly cut off from the mainland on the north by Turnagain Arm and Portage Bay. These two bodies of water are arms of Cook Inlet and Prince William Sound, respectively, and are separated from each other by a strip of land 12 miles wide and 1,000 or 1,100 feet above sea level at its lowest point.

HISTORY.

EARLY EXPLORERS.

The region about Cook Inlet is historically one of the most interesting in all Alaska. First entered by Captain Cook in his search for the elusive northwest passage, it later became the scene of bitter strife between rival fur companies and of the earliest effort to develop the unknown mineral resources of the vast area known as Russian America. It is not, however, the purpose of this review to give a detailed account of the events that occurred after the discovery of the inlet by white men, except in so far as these relate to the investigation or development of the mineral resources of Kenai Peninsula. Suffice it to say that Cook Inlet, or the Gulf of Kenai, as it was called by the Russians, was visited in 1778 by Captain Cook, who spent some time in exploring its shores. The names Turnagain River (Arm), Point Possession, Anchor Point, Point Bede, Cape Elizabeth, and Barren Islands were all given by Captain Cook, after whose death the supposed river, by direction of Lord Sandwich, was named Cook River.

[a] An abstract of this paper has been published, under the title Gold Placers of Turnagain Arm, in Bull. U. S. Geol. Survey No. 259, 1905, pp. 90–99.

The inlet was again visited by English ships under command of Portlock and Dixon in 1786. These explorers remained for nearly a month, during which time they met with considerable success in trading for furs and, more important still from the standpoint of this report, made the first discovery of coal-bearing beds at Coal Bay, on the east side of Port Graham. Neglecting the Russian investigations carried on in the development of the Cook Inlet fur trade, we may next turn to the explorations made in 1794 by Capt. George Vancouver. His surveys were among the most valuable made on this part of the Alaskan shore and resulted in substantial corrections of Captain Cook's charts, especially with regard to latitude. Before he sailed from the inlet he had determined the fact, long known to the Russians, that its waters did not represent the mouth of a great river, as Cook had supposed, and the name Cook River was therefore changed to Cook Inlet.

MINING.

Early mining.—The first attempt to develop the mineral resources of Alaska was made in 1848 by P. P. Doroshin, a Russian mining engineer, who was sent from St. Petersburg by the Russian-American Company to examine Baranof Island and the Cook Inlet region. The locality which he chose for investigation on Kenai Peninsula was the Kenai River Valley, but although he found gold-bearing gravels he was not successful in finding gold in commercial quantities, the product of two seasons' labor, the summers of 1848 and 1850, amounting to only a few ounces of the precious metal. Doroshin himself says that work was confined to a tributary of the lower lake (Lake Skilak) and to two streams flowing into the river (Kenai River) connecting the upper and lower lakes, and that the quantity of gold obtained nowhere exceeded 0.0000004 of the gravels moved. Prospecting was greatly hindered by difficulties encountered in ascending the river, by the necessity of transporting all supplies on the backs of men, and in one case by forest fires. He further states that while the small results cooled the ardor of the chief manager of the Russian-American Company for gold seeking, he himself was convinced that gold was present and hoped that some other engineer might be more fortunate in finding it.[a]

One other effort to profit by the mineral resources of the region was an attempt, made about this same time, to establish a market in California for coal from Port Graham. Coal mining was undertaken by the Russian-American Company in association with merchants in San Francisco, but the venture did not prove successful. A further account of this undertaking will be found in Mr. Stone's accompanying paper on the coals of Kachemak Bay and vicinity, page 54.

Placer development.—The second period in that part of the economic history of the Kenai Peninsula relating to its mineral resources begins with the discovery of placer gold in the Turnagain Arm field. The exact year when prospecting began is perhaps not known, but it is said that gold was found near Hope about the year 1888 by a man named King, and that the first claim was soon afterwards located on Resurrection Creek, 2 miles above Hope, by Charles Miller. He did not work the ground himself, but leased it to others, and is reported to have "made a good living for ten years and never hit a lick." Gold was found near by, on Bear Creek, in 1894, by George Beady, F. R. Walcott, and —— Riley. This stream is said to have been worked by the Russians, but if this be true such operations must have taken place later than the time of Doroshin, for he expressly states that the streams prospected by him were tributary to what is now known as Kenai River.

Gold was found on Palmer Creek by George Palmer in 1894. These discoveries naturally led to prospecting on neighboring streams, and in the following year (1895)

[a] Petrof, Ivan, Population, resources, etc., of Alaska: Tenth Census of the United States, vol. 8, 1884, p. 78.

the first stakes were driven on Mills Creek by S. J. Mills, whose name it bears. Mr. Mills at the same time staked ground at the forks of Sixmile Creek (also named by him), which has been worked with profit to the present time, but the ground on Mills Creek was regarded with so little favor by Mills's partner, for whom it was staked, was so far from supplies, and so difficult to reach, that no attempt was made to work it, nor was the claim recorded. Some time during the following month (July, 1895) coarse gold was found on Mills Creek by Robert Michaelson and John Renner, old Yukon miners, who had been prospecting for quartz ledges in the mountains east of Canyon Creek without success and were returning to Hope. These two men, together with three others—Albert Brown, W. W. Price, and H. C. Pierce—staked ground on Mills Creek, July 29, and formed a company known as the Polly Mining Company. Their claims included all the stream between the mouth and Juneau Creek, and have since proved to be among the most valuable properties in the Turnagain field. In July, 1895, an assembly of miners from streams in the Sixmile drainage basin formed the Sunrise mining district and elected a local recorder. This recording precinct was distinct from the older Turnagain Arm district, which included the Resurrection Creek drainage system and, later, the creeks north of the arm. The two precincts were afterwards united, and recently, much against the desires and convenience of those most interested, the books of the recorder were removed to Seward, where they now are. Other discoveries of gold were made in the Sunrise district during the same year (1895), notably that on Lynx Creek by Fred Smith and W. P. Powers. North of the arm the first gold was found (in 1895) by F. J. Perry and Christopher Spillum, on California Creek.

The discoveries on Mills and Canyon creeks brought about during the following season (1896) the first considerable rush of prospectors to this field. Several thousand men, some state the number as high as 3,000, are said to have landed at Tyonok en route for Turnagain Arm and Sushitna River, while a considerable number crossed by way of Portage Glacier from Prince William Sound. This was the banner year on Canyon Creek, 327 men being engaged in mining its gravels during the summer. Crow Creek, tributary to Glacier Creek, was also staked about this time, but did not produce any gold till two years later. A second rush into the Turnagain Arm field took place in 1898. This was partly an overflow from the Yukon stampede and was not entirely due to the successes on Resurrection and Sixmile creeks.

A majority of the men who first entered the field (1894–95), as well as a few of those who took part in the stampedes of 1896 and 1898, were experienced miners. Many of them had spent years in southeastern Alaska or the Yukon country and nearly all had mined in the placer fields of the West. On the other hand, most of the later comers were inexperienced in any kind of mining and many were scarcely able to take care of themselves. Thousands of dollars worth of useless machinery and supplies are said to have been landed at Tyonok for transfer to the arm, only to be abandoned or given away. Several expeditions spent months in hauling cumbersome and unsuitable outfits through an unknown wilderness to localities which none of their members had ever visited and possibly never had heard of till they reached Alaska. Expensive hydraulic plants were established for the treatment of gravels that had never been prospected. It is doubtful if there is any other part of Alaska where time and money have been wasted in a more enthusiastically ignorant manner or concerning which stockholders in mining companies have been more utterly misled than some places on the Kenai Peninsula. The field did not justify the presence of any such numbers as came, and disappointment was the only result possible for most of them. Such conditions could produce only a feeling of distrust in the minds of those who had money to invest in mining enterprises, and hinder, in a serious way, the development of a field, many parts of which have since been worked with profit, and which without doubt still contains valuable gold deposits.

EXPLORATION AND SCIENTIFIC INVESTIGATION.

Early exploration.—The presence of sea otter and salmon in the waters of Cook Inlet and the growth of a profitable fur trade with natives from the interior had led very quickly to acquaintance with a narrow strip of land bordering the inlet, but until the discovery of gold in commercial quantity little was known of the mountains back from its shores. After the purchase of Alaska by the United States, American companies continued the fur trade, establishing stations at various points. Their agents endeavored to gather all the data relating in any way to the commercial possibilities of the country, including, of course, the positions and descriptions of routes and trails. From time to time, also, exploring parties sent out by different departments of the United States Government visited the inlet and collected in various ways information on which much of our knowledge of the geography and natural resources of the region is based.

Among the more prominent of those contributing to a knowledge of the geology several names should be mentioned. Baron von Wrangell, for a time manager of the Russian-American Company's interests in Alaska, gave an account, among other things, of the volcanoes along the west shore of Cook Inlet and the coal beds of Port Graham.[a] Wosnesenski, who spent several years in Alaska at the expense of the Imperial Academy of Sciences of St. Petersburg, also visited the coal-bearing beds of Kachemak Bay.

Heer[b] described the fossil plants collected at Port Chatham by Furuhjelm. Grewingk[c] published a geologic map of the shore line of southern Alaska and a geologic section along the coast of Kenai Peninsula from Kachemak Bay to Kasilof River, based on data furnished by Wosnesenski and others.

Among later writers, Dr. William H. Dall[d] published the first comprehensive statements on the coals of Kachemak Bay and Port Graham as well as a description of the Kenai beds in which they occur. Dr. G. F. Becker[e] published a report on the gold deposits of Alaska, in which the then recently discovered gold placers on Turnagain Arm were mentioned. The work of Messrs. Dall and Becker in 1895 was one of the first investigations in Alaska undertaken by the United States Geological Survey. In 1898 Mr. Mendenhall,[f] also of the Survey, made a hasty trip across the peninsula from Resurrection Bay to Sunrise, and in the following year published the most reliable map of the region available since that time. This journey was part of the exploratory work of a party under the command of Capt. E. F. Glenn, who was sent by the War Department to discover, if possible, a practicable route from Cook Inlet to the Tanana.

Thus many of the major features of portions of the region were learned, while here and there less prominent facts were brought to light through the wanderings of prospectors and hunters.

Investigation in 1904.—These, then, were the conditions when in the early part of the year 1904 it was decided to send a reconnaissance party from the United States Geological Survey into the region between Cook Inlet and Prince William Sound, known as the Kenai Peninsula. The purpose of this party was twofold, first,

[a] Von Wrangell, Baron F. P., in Baer and Helmersen, Beiträge, vol. 1, 1839.

[b] Heer, Oswald, Flora fossilis Alaskana: Kongl. Svensk. Vet.-Akad. Handl., vol. 8, No. 8, Stockholm, 1869.

[c] Grewingk, C., Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nord-West-Küste Amerikas, mit den anliegenden Inseln: Verhandl. Russ.-k. mineral. Gesell. zu St. Petersburg, 1848, 1849; also separates, 1850.

[d] Dall, William H., Report on coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, pp. 762–908. Also Correlation Papers—Neocene: Bull. U. S. Geol. Survey No. 84, 1892, pp. 232–268.

[e] Becker, G. F., Reconnaissance of the gold fields of southern Alaska, etc.: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp, 1-86.

[f] Mendenhall, Walter C., Reconnaissance from Resurrection Bay to Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, pp. 265–340.

to prepare a topographic map, and, second, to make a geologic reconnaissance of the region visited. The important area to be studied was the Turnagain Arm placer gold field, but in addition it was desired to map as much of the peninsula as circumstances would permit, and especially, if sufficient time remained after the completion of the more important work on the gold-producing creeks, to make a hasty journey through the central portion of the peninsula from Turnagain Arm to Kachemak Bay, in order to locate and map the several large lakes there which were known to the early Russian traders. The topographic work was placed in the hands of Mr. E. G. Hamilton, while the task of visiting the gold-producing creeks fell to the writer, who had charge of the expedition. In addition to the two members just named the party consisted of J. W. Bartlett, chief packer, J. G. De Forest, R. A. Hamilton, Court Benton, and Benito Alexander. Three of these men had had previous experience in Alaskan work, and all were valuable members of the party. To their willing aid at all times the success of the expedition is largely due. The writer wishes to take this opportunity to express his obligation also to the many men whose hospitality he has shared, or who have furnished him with aid or information during his season's work on Kenai Peninsula.

The necessary provision and camp equipment for the work of the party during the summer was secured in Seattle. Ten horses were taken and supplies for four months' work, since it seemed probable, from previous experience, that a longer working season would be possible on Kenai Peninsula than in the more northerly portions of Alaska. A part of these provisions was sent to Seward for immediate use during the first part of the work, while the remainder was shipped to Sunrise, on Turnagain Arm, where the party was expected to arrive about July 1. The expedition sailed from Seattle May 22 on the steamer *James Dollar*, in company with a second Geological Survey party in charge of G. C. Martin, with whom were associated T. W. Stanton and R. W. Stone. This party expected to make a geologic study of the coal and oil fields of the southern part of Kenai Peninsula and the eastern part of Alaska Peninsula. Mr. Stone's report on the coal fields of Kachemak Bay and Port Graham forms a part of this bulletin (see pp. 53–73).

A landing was made at Seward May 29 and camp was pitched on the beach. The plan of operation was to begin topographic mapping and geologic investigation at Resurrection Bay, thence to carry it northward across the eastern side of the peninsula to the gold fields of Turnagain Arm, and finally to close the season's labor by a trip along the foothills of the Kenai Mountains to Kachemak Bay. It was desired, if weather conditions permitted, to begin a system of triangulation which could be carried along with the topographic work, and thus establish the location of points to which later topographic work about Cook Inlet could be tied. The work of triangulation on Resurrection Bay proved impracticable, however, and had to be given up because of fogs and cloudy weather. Eight days were spent in mapping the region about Resurrection Bay, the work being done chiefly by boat and being interrupted by frequent rains.

Leaving Seward the party proceeded northward by way of Salmon Creek and Snow River to Kenai Lake, where, procuring a boat, several days were spent in mapping the shore lines and in making a second attempt to carry out the plan of triangulation. This latter effort, however, met with no better success than the first at Seward, and the plan was finally given up entirely. Leaving the lake the party followed Trail Creek to the mouth of Johnson Creek, and, ascending the latter stream, crossed over the divide to the head of Bench Creek. Bench Creek led to the east fork of Sixmile Creek, and camp was finally made about July 1, near the mouth of Canyon Creek, at "the forks." Provisions having been replenished from the supply at Sunrise, the party proceeded southward to Mills Creek, thence to Quartz Creek, and crossed the high divide between Summit and East creeks to the head of Resurrection Creek

Valley. After examining the placer deposits in this valley the party returned to Sunrise. It was then necessary to change the mode of traveling, for it was found impracticable to take horses around the head of Turnagain Arm. A boat was therefore procured, by which the streams east of Sunrise on both sides of the arm were reached. An examination of the placer gold deposits on Crow Creek completed the work in this region and the party returned to Sunrise, where the horses were again procured and the necessary preparations for the final part of the season's work were made. From Sunrise the route lay southward to Lake Kenai and down Kenai River to the lower end of Lake Skilak. It was intended to follow the foothills of the Kenai Mountains from Lake Skilak to Lake Tustumena, from which place it was thought that the east shore of Kachemak Bay and Homer could be reached with little difficulty. However, freezing weather and the increasing scarcity of feed for the horses forced the abandonment of this plan, and the party moved directly westward across the Kenai Flats to the town of Kenai. Two days later a steamer arrived for Seldovia, at which place the party landed September 29. The labors of the field season were completed by ten days' work along the southern shore of Kachemak Bay, and the party embarked from Seldovia October 18, arriving in Seattle November 5. During this trip of more than five months' duration an area of slightly more than 1,600 square miles was mapped topographically, all the producing gold placers of the peninsula were visited, and a geologic reconnaissance was carried over the whole area.

TOPOGRAPHY.

SHORE LINE.

Kenai Peninsula possesses a shore line more than a thousand miles long (Pl. I and fig. 1), an unusual length relative to its area and more remarkable because of its diversity. The outline of the whole southeastern coast from Portage Bay to Kachemak Bay is exceedingly irregular, deep indentations and projecting land masses, together with numerous islands, giving it a very broken appearance. Steep mountains, with rugged tops and with sides scarred by snowslides or landslides, rise abruptly from the water's edge and give to the landscape an aspect that is at once grand and forbidding.

Of the numerous bays which indent the coast of the Pacific and of Prince William Sound one only, Resurrection Bay, gives direct access to the interior of the peninsula. This bay, the Voskresenskaia, or Sunday, Bay of the Russians, is about 10 miles long and affords an excellent harbor, protected on all sides and open throughout the year, for which reason it was chosen as the southern terminal of the new railroad now under construction.

Portage Bay, in Prince William Sound, furnishes a means of communication between the upper parts of the sound and Cook Inlet. The portage over the glacier, though somewhat steep on the eastern side, is not difficult in favorable weather. It was made known to the Russians by the Indians, who traveled it long before the coming of white men, and was used by many of the earlier prospectors in entering the Turnagain Arm gold field.

The other larger bays on the Pacific side, Aialik, Nuka, and Port Dick, offer anchorage and protection from wind and waves, but, since they are cut off from the interior by high mountains, can hardly be of great future importance unless valuable mining properties are developed in their immediate vicinity. Port Chatham and Port Graham, or English Bay, on the Cook Inlet coast, were known and used by the Russians and at the present time often afford protection during stormy weather to the boats sailing these waters. Seldovia Bay, still farther north, is entered by large vessels and is the place where mail and freight destined for the upper settlements on Cook Inlet are transferred to the small steamer making that run.

HEAD OF TURNAGAIN ARM AT LOW TIDE.

The mud flats are covered at high tide. Portage Glacier is on the left and one of the small Glacier River glaciers is on the right.

The ragged coast line characteristic of the Pacific side continues around the southern end of the peninsula and northward into Kachemak Bay, where it gives place to a coast line of entirely different character.

Beginning with the north shore of Kachemak Bay and extending up the west side of Kenai Peninsula to Gull Rock, on Turnagain Arm, the coast is marked by a line of steep bluffs, without pronounced indentations, and only occasionally broken by stream channels. The bluffs reach their highest elevation in the vicinity of Homer and Kachemak Bay and gradually decrease in height toward the north. The unconsolidated gravels of the bluffs along some parts of the east side of Cook Inlet are gradually undermined by the waves, in consequence of which minor variations in the shore lines have taken place in very recent times. There is deep water at Homer Spit and along the southern side of Kachemak Bay, but the north side and upper end become a broad mud flat at low tide. Large vessels also find anchorage at Fire Island, in the upper end of Cook Inlet, while light-draft vessels may enter Turnagain Arm and the mouths of Kenai and Kasilof rivers at high tide. Besides these, however, there are no harbors on the Cook Inlet side of Kenai Peninsula for either large or small steamers. The mouths of Kenai and Kasilof rivers are marked by sand bars or mud flats that extend for long distances into the inlet, and familiarity with the channels is necessary in order to navigate the streams safely.

The shore of Turnagain Arm resembles that of the southern coast of the peninsula, in that the mountains on either side rise abruptly from the water. At low tide the arm becomes a wide mud flat crossed by stream channels whose positions are never fixed, but migrate yearly from one place to another (Pl. III). This flat has a gradual westward slope, and the high tides that are so dangerous near the entrance of the arm barely reach its eastern end. The whole of the Cook Inlet region is remarkable for its tides, whose swift currents often proved disastrous to the crazy craft of the early Russian traders, and have more than once caused the loss of life and property in recent years. A difference of 32 feet between high and low tide was measured at Homer wharf, near the mouth of Kachemak Bay, and the writer was told that a difference of 52 feet had been observed near the entrance to Knik Arm.

RELIEF.

The relief of Kenai Peninsula, like its shore line, presents two widely differing features. In fact, the form of its shore line results from differences in the relief of its land surface. Much the larger portion of the peninsula is a region of high mountains with rugged summits and deeply cut valleys (fig. 1). This mountainous region occupies the eastern part of the peninsula and makes up approximately three-fourths of the total area. Like the peninsula itself, the mountainous area is widest (60 to 70 miles) in the north, its width gradually decreasing toward the southwest, until near Seldovia it is reduced to not more than 20 miles. The remaining fourth includes the broad plateau extending along the whole western side from Kachemak Bay to Turnagain Arm. This plateau is about 25 miles wide and slopes gently northward from the high table-land back of Homer to the Chickaloon Flats, south of the arm, or from an elevation of about 1,800 feet on the south to an elevation of about 50 feet on the north. The surface is slightly undulating, is dotted with numerous small ponds or swamps, and is crossed by winding streams. Stunted growths of timber, chiefly spruce and poplar, are interspersed with marshy areas, and a thick carpet of moss covers much the greater part of the region.

The Kenai Mountains reach an elevation of as much as 6,000 or possibly 7,000 feet in the north, but are not so high in the south. The axis of the chain lies well toward the eastern side of the peninsula and thereby gives rise to peculiarities of drainage which will be referred to later. Numerous glaciers originate in the higher portions of the range and several approach within short distances of the coast, where the

débris brought down by the ice forms broad flats, crossed here and there by the ever-shifting watercourses. It has been said that the mountains are peculiarly rugged, but an exception is found in the smoother rounded hilltops north of Kenai River and east of the upper part of Resurrection Creek. As will be seen later, the appearance

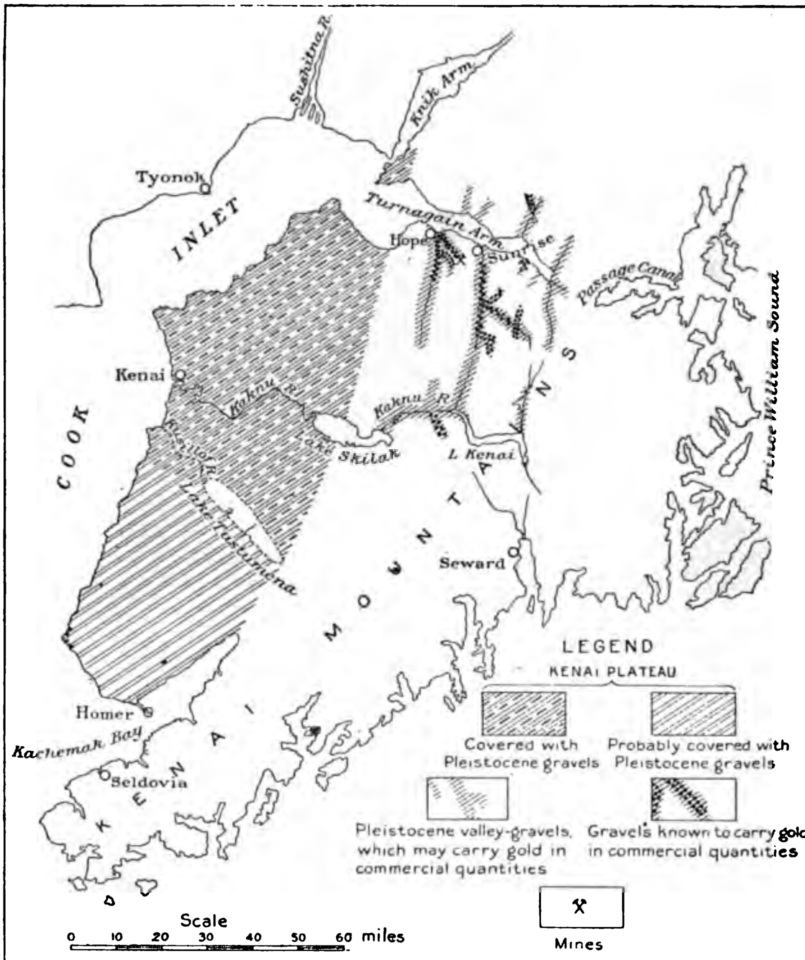

FIG. 1.—Sketch map of Kenai Peninsula, showing plateau and mountain areas, distribution of Pleistocene gravels in northern and western portions, and gold-bearing gravels now being developed. (The Board on Geographic Names has recently changed the name of Kaknu to Kenai River. For "Kusillof R." read Kasilof R.)

of these mountains has been modified by glaciation more profound in its effects than any that took place to the south.

DRAINAGE.

Owing to the fact that the axis of the Kenai Mountains is close to the eastern or southeastern side of the peninsula, the drainage is principally toward the west and north, while the streams flowing into the Pacific and Prince William Sound are short (Pl. II). The two largest streams of the peninsula, considering the volume of water which they carry, are Kenai and Kasilof rivers, which flow into Cook Inlet within a short distance of each other. Both rivers drain large lakes and both receive no small

part of their waters from melting glacial ice, as is evident from their white appearance, due to rock flour carried in suspension. The Kenai River system is much the longer of the two. The upper part, known as Snow River, is a glacier-fed stream rising in the mountains bordering the west side of Prince William Sound. It is about 10 miles long and flows into the upper end of Lake Kenai, which has a length of 22.5 miles and is merely a widening of the stream due to the deposition of gravels in the valley at its lower end. The portion of Kenai River between the upper and lower lakes, Kenai and Skilak, is 16 miles long. For a distance of several miles below Kenai Lake the grade is gentle and the water quiet, but as the stream approaches the lower lake the swiftness of its current increases, and at one point the channel contracts to a narrow rock-walled canyon. From Lake Skilak to Cook Inlet the stream meanders widely, forming a series of bends and oxbows, whose total length of 53 miles is more than 50 per cent greater than the distance directly from the lake to the mouth of the river. From the mouth of the middle river (the portion between the lakes) to the head of the lower river the distance is 14.5 miles, and the length of the lower river is 53 miles, thus making the total length of the stream, including Snow and Kenai rivers and the lakes, 116 miles.

The grade of the lower river is not great; the highest tides reach a point 15 miles above the town of Kenai, and there is no swift water below Moose River. The rapids, about 2 miles above Moose River, are somewhat dangerous for boats in time of low water, because of numerous bowlders in the channel.

Kasilof River, draining Lake Tustumena, the largest body of fresh water on the peninsula, is much shorter than lower Kenai River and is not so crooked, but, like it, possesses a low grade, so that small boats are taken with little difficulty from the cannery at the mouth to the lake. These two rivers have long been used as highways by the natives, who ascend them in bidarkas, and who at one time inhabited a number of villages along their banks and on the shores of the lakes drained by them. Lakes Skilak and Tustumena lie on the borderland between the Kenai Mountains and the flat country west of them. Lake Skilak has a total length of 16 miles and a maximum width of 4 miles and is about 386 feet above sea level. The eastern half of the lake is surrounded by high mountains which give place on the west to the low, rolling hills of the Kenai Plateau.

Lake Kenai, as has been stated, has a length of 22.5 miles, a maximum width of only 1.5 miles, and an elevation of 435 feet. Its peculiar form will be best understood by referring to the map (Pl. II). The mountains rise abruptly from the water and are strewn with débris from the upper slopes, so that traveling along the shores is difficult. Lakes Kenai and Skilak are commonly known to the miners of Turnagain Arm as Upper and Lower Kenai lakes.

Lake Tustumena was not visited by our party, but is reported to be 35 miles long and about 9 miles wide. One or two large glaciers and a number of short streams drain into it.

Besides the two rivers previously described, two smaller streams, Chickaloon and Indian rivers, cross the upper part of the Kenai Plateau. These two streams flow toward the north and empty their waters into Chickaloon Bay, the western end of Turnagain Arm. In addition to those named, a number of minor streams drain the numerous small lakes and ponds of the plateau and find their way into Cook Inlet or Kachemak Bay.

The streams of the Pacific and Prince William Sound slopes are short, none of them, with the exception of Resurrection River, being over 10 or at the most 15 miles long. They occupy steep, narrow valleys and often descend from the mountain sides to the sea in a series of waterfalls. The waters of many of these are derived in part from glaciers or melting snows and consequently vary greatly in quantity at different seasons of the year. Resurrection River is between 20 and 25 miles long. It rises in the mountains southwest of the northward bend in Lake

Kenai and flows through a wide gravel-floored valley to the head of Resurrection Bay. Its waters are derived partly from melting glacier ice.

The principal streams flowing into the eastern half of Turnagain Arm are Resurrection Creek, Sixmile Creek, and Glacier Creek. These all have a general northerly direction and carry considerable water; but as they lie within the placer gold field, whose drainage will be described in greater detail in the section on economic geology, they are merely mentioned here.

GENERAL GEOLOGY.

Lack of variety is a noticeable feature of the rocks found throughout a large part of Kenai Peninsula and is especially apparent in hasty reconnaissance work, where there is little opportunity to study details.

SEDIMENTARY ROCKS.

DISTRIBUTION.

In order to present a clearer idea of the rocks and their general relationships, a brief résumé of the known facts concerning them will first be given, after which the various lithologic units will be described at greater length. These units are partly of sedimentary and partly of igneous origin, the former being here divided into five groups, whose chief characteristics are described below:

1. The central and northern Kenai Mountains are made up principally of interbedded gray, black, or bluish-black slates and gray arkoses, possessing, as a whole, a remarkably uniform appearance and composition. Interstratified with the slates and arkoses are occasional conglomerate and quartzite beds, but these do not form any considerable part of the mountain mass and are irregular in their occurrence. Locally the series is cut by granitic dikes. This succession of sedimentary beds includes the oldest known rocks of the peninsula, and, although its age is not definitely known, is referred to the upper Paleozoic. It was named the Sunrise "series" by Mendenhall.[a]

2. South of Kachemak Bay the Kenai Mountains near the coast are made up chiefly of contorted red and green cherts and green diabase, cut by light-colored porphyritic dikes (Pl. IV, *B*). The relation of these rocks to the Sunrise "series" is not known, but Stanton refers them tentatively to the Triassic.

3. At various localities along the coast from Kachemak Bay to Port Graham are bedded fragmental rocks ranging from fine-grained tuffs to agglomerates, tilted and slightly folded but much less altered than the cherts on which they are believed to have been deposited unconformably. They are fossiliferous and on the evidence of the organic remains found in them are considered to be of lower Jurassic age.

4. The upper member of the list of bedded sedimentary rocks is a succession of sandstones and shales, with interbedded coal seams, which overlies the lower Jurassic unconformably and forms the whole northern coast line of Kachemak Bay and the eastern coast line of Cook Inlet as far north as Cape Kasilof. Isolated masses of these rocks also occur at various points on the south shore of the bay. These beds, while slightly folded and sometimes faulted, are not always thoroughly consolidated. They were described by Dall and furnish the type exposures of his so-called Kenai beds, which he referred to the Miocene, but which are now considered to be of late Eocene age.

5. Finally, the Kenai Plateau is overlain unconformably by thick deposits of silts, sands, and gravels, which extend also into the valleys of the Kenai Mountains. At the mouth of Kenai River the gravel bluffs are between 75 and 100 feet above tide, but farther east the gravels in some of the valleys reach an elevation of nearly 2,000

[a] Mendenhall, W. C., Reconnaissance from Resurrection Bay to Tanana River, Alaska, in 1898: *Twentieth Ann. Rept.* U. S. Geol. Survey, pt. 7, 1900, p. 305.

feet. These gravels are largely of glacial origin, and were laid down before the retreating ice front.

The geologic column of Kenai Peninsula therefore includes the supposedly Paleozoic Sunrise "series," red and green cherts of probable Triassic age, lower Jurassic sediments of the Seldovia region, and the Eocene Kenai beds which form the tilted plateau at the foot of the Kenai Mountains. To these must be added the surficial deposits of Pleistocene and Recent time. This succession is represented in the following table:

Geologic column of Kenai Peninsula.

Age.	Period.	Epoch.	Remarks.
Cenozoic	Quaternary	Pleistocene	Silt, gravel, and sand of the Kenai Plateau and high gravels found in the valleys of Kenai Mountains.
			Unconformity.
	Tertiary	Eocene or Oligocene.	Kenai formation.
			Unconformity.
Mesozoic	Jurassic		Lower Jurassic beds of Seldovia Bay.
			Unconformity.
	Pre-Jurassic (Triassic?).		Chert beds of Kachemak Bay, etc.
Paleozoic(?)			Sunrise "series."

SUNRISE "SERIES."

Occurrence.—The slates and arkoses of the Sunrise "series" form the mass of the Kenai Mountains in the middle and northern part of the peninsula. Toward the south they give place partly or wholly to other rocks, some sedimentary, some igneous, which will be described later in the portion of this paper dealing with the Kachemak Bay and Port Graham regions (pp. 19–25).

Character.—The slates are usually fine grained and often possess a cleavage so well developed that in some localities it is possible to break them into thin plates like roofing slate. Locally they are schistose. The arkoses are composed chiefly of angular fragments of quartz and feldspar, derived from the disintegration of the rocks of an ancient land mass. Under the microscope the particles are seen to be remarkably fresh, indicating that the weathering of the original rocks was rapid, and that from a geologic point of view the period during which they accumulated was short. They differ greatly in the size of their particles; some beds are of uniform grain, while others show coarse material in a finer groundmass and approach the conglomerates in structure. Flat pieces of slaty rock, or even bowlders, appear in some beds, but these do not resemble the rounded pebbles of the typical conglomerates and do not form so large a proportion of the bed. The whole rock series is closely folded, and the arkoses as well as the slates show cleavage, which, however, is much less well developed in the former than in the latter. Jointing is more noticeable in the arkoses than in the slates, and divides them into irregular angular blocks that are readily displaced by frost and ice. These blocks are conspicuous in the talus slopes below arkose ledges. Large blocks in the stream channels are more generally arkose than slate. This is probably due in part to the better developed jointing of the arkoses, and in part to planes of weakness in the slates resulting from their more perfect cleavage, which allows them to be broken up more easily.

The general strike of the sedimentary beds in the vicinity of Resurrection Bay is about N. 10° E., but in going northward toward Turnagain Arm it was found that, aside from local variations, the strike gradually becomes more easterly and suddenly reaches a maximum easterly deviation on the north shore of the eastern end of the

arm, where a strike of N. 60°–70° E. prevails. The strike of the cleavage, however, which near Resurrection Bay is in general the same as that of the bedding, remains nearly constant, so that from Glacier Creek eastward there is often a large angle between the strikes of cleavage and bedding. While folding is often close the beds are not generally overturned. Faults are numerous and have probably had an important influence in determining the topography of the region, especially the form of Kenai Lake and some of the other valleys, but the amount of displacement is difficult to determine owing to the uniformity of the Sunrise "series" and the lack of reference beds from which to make measurements.

The composition of the occasional conglomerate beds throws some light on the source of part of the material making up the arkoses, for both may have been formed, to a certain extent, by the weathering of the same rocks. The pebbles of the conglomerates vary somewhat in different localities, but they are always well rounded and consist chiefly of argillaceous rock and granite, with less frequent quartzite or quartz. A conglomerate bed 6 to 8 feet in thickness on Resurrection Creek is made up of rolled granite pebbles with a few rounded quartzite fragments in a gray argillaceous groundmass. Quartzite beds are usually of no great thickness and were observed most frequently east of Resurrection Bay, west of Resurrection Creek, and along the north shores of Turnagain Arm. Several massive quartzite beds, from 4 to 6 feet thick, are conspicuous in the vicinity of the glacier east of Seward, about 2 miles from the bay. The beds here, which lie in immense folds, slightly overturned to the east, furnish the best instance of overturning met during the season. The arkoses sometimes approach the quartzites in appearance owing to a large increase in the amount of quartz present. Conglomerates and quartzites, while they attract attention locally, form a relatively unimportant part of the Sunrise "series," whose principal members are the slates and arkoses just described.

Age.—No fossils have been found in the Sunrise "series" on Kenai Peninsula and as yet there is no evidence on which a definite statement of its age can be based. Mendenhall made a provisional correlation of the Sunrise "series" with the Valdez formation of Prince William Sound, described by Schrader[a] as consisting of highly metamorphosed "bluish-gray and dark quartzites, arkoses, and quartz-schists, interbedded with generally thin beds of dark-blue or black slate, shale, mica-schist * * * and stretched conglomerates." The correlation was based on lithologic similarity. According to Mendenhall the rocks of the "Matanuska series," occurring in the valley of Matanuska River, probably overlap the Sunrise "series" from the northwest. Part of the Matanuska rocks are of lower Cretaceous age, and he therefore concludes that the Sunrise "series" is pre-Cretaceous and assigns it provisionally to the upper Paleozoic.

Schrader and Spencer[b] later suggested a possible identity of the "Orca series" (also found on Prince William Sound) and the Sunrise "series." They further state that the "Orca series" may be equivalent to the "Yakutat series," but the fossils of the latter were also found at Kadiak Island and are regarded by Ulrich[c] as indicative of the lower Jurassic. The lower Jurassic beds of Seldovia, while they may not be equivalent to those of Kadiak Island, are, as will be shown later, distinctly younger than the Sunrise sediments. It is apparent, therefore, that if the "Yakutat series" is really of Jurassic age and the Orca-Yakutat correlation holds, the Orca-Sunrise correlation can not hold.

One other statement is here presented as having some bearing on the age of Sunrise "series." The relation of the previously mentioned red and green

[a] Schrader, F. C., Reconnaissance of a part of Prince William Sound and the Copp[illegible] Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, p. 408.

[b] Schrader, F. C., and Spencer, A. C., The geology and mineral resources of a por[illegible] River district, Alaska: Special publication U. S. Geol. Survey, 1901, p. 36.

[c] Ulrich, E. O., Alaska, geology and paleontology: Harriman Alaska Expediti[illegible]

A. JURASSIC CHERTY LIMESTONE, ETC., AT PORT GRAHAM.

Two miles southeast of the coal outcrops.

ONTORTED CHERTS AT SELDOVIA BAY.

he middle of the picture, diabase on the right.

the Sunrise sediments is not definitely known. No fossils were found in them, but Stanton regards them as probably Triassic. Reasons for this determination will be given in the proper place. The cherts are sharply folded and much faulted, but are not so much altered as the slates and arkoses, a fact which may be due to differences in the lithologic character of the beds or differences in the intensity of the forces producing alteration, or both. If, however, it can be regarded as indicating an age less than that of the Sunrise sediments, we have further evidence that Mendenhall's provisional assignment of them to the Paleozoic is correct. We may say, therefore, that no paleontologic evidence has yet been discovered on Kenai Peninsula fixing the upper age limit of the Sunrise formation more definitely than that it is pre-Jurassic.

CHERTS.

Occurrence.—The contorted cherts that occur at numerous localities along the shores of Kachemak Bay and Cook Inlet (Pl. IV, *B*) from Aurora to Port Graham have been described by several writers, but more especially by B. K. Emerson and Charles Palache in the account of the Harriman Alaska Expedition. The results published by them will be freely used to amplify the observations made by various members of the Geological Survey during the season of 1904.

Since these cherts were involved in at least a part of the main movements that affected the Kenai Mountains, and since their exact relation to the Jurassic sediments is not known, they are here discussed in connection with the Sunrise "series," although it is thought that future investigation will probably separate them. Typical exposures, such as those found near Seldovia village, on Yukon Island, or at Halibut Cove, present a succession of very regular thin chert beds, rarely over 2 or 3 inches thick, separated by clay or shale partings. In at least two localities, especially near the east side of the entrance to Seldovia Bay, calcareous siliceous rocks occur which are thought to belong in the same "series."

Character.—The origin of the cherts was recognized by Professor Palache, who described them as radiolarian cherts. They are red or green in color, and the beds are strikingly folded (Pl. IV, *B*). Faults are not infrequent. The movements which affected the cherts resulted in the production of a vast number of small fissures, which have since been filled with quartz and calcite and are now shown on the rock surface, or in a thin rock section, by a fine network of sharply defined quartz and calcite veins.

These cherts are associated with masses of green diabase, which probably were intruded after the formation of the chert beds, although it is possible that the masses of igneous rock were poured out at different times while the cherts were forming and that the present irregular occurrence of the cherts resulted from faulting. No contact alterations were noticed in the cherts by members of the survey parties, nor were any distinctly extrusive characteristics seen in the diabases, which, however, have been greatly disturbed and considerably altered. Both the cherts and the basic igneous rocks are cut by light-colored porphyry dikes. These igneous rocks will be discussed later.

Age.—In the account of the Harriman Alaska Expedition [a] the extraordinary similarity in structure and lithologic character of the Halibut Cove cherts and associated igneous rocks (except the porphyry dikes) to rocks of the same kind occurring in the Franciscan formation of the California Coast Range is pointed out. The California cherts were described by Lawson [b] and were doubtfully assigned to the Jurassic or to the very lowest Cretaceous. Professor Emerson [c] makes the statement that "correlation over such wide distances, based only on lithologic similarity, has of

[a] Alaska, geology and paleontology. Harriman Alaska Expedition, vol. 4, p. 26.
[b] Lawson, A. C., Geology of the San Francisco peninsula: Fifteenth Ann. Rept. U. S. Geol. Survey, 1895, p. 420.
[c] Emerson, B. K., Alaska, geology and paleontology: Harriman Alaska Expedition, vol. 4, p. 27.

course little value, but taken in conjunction with other evidence for the existence of Mesozoic rocks in the Cook Inlet region, the facts may here be given a certain amount of significance."

Evidence collected by Stanton in 1904, while not decisive, points to a greater age for the cherts than that suggested by Professor Emerson. The cherts of Kachemak Bay and Seldovia resemble other banded and contorted cherts in Kamishak Bay on the west side of Cook Inlet. The latter cherts yielded upper Triassic fossils, and though the same objection to correlation by lithologic characters over a considerable distance might be raised, yet in this case it appears that such objection would have far less force. Further, although no contact was seen, the fossiliferous tuffs and sandstones near Seldovia probably overlie the cherts. Stanton's evidence indicates that these tuffs and sandstones belong to the lower Jurassic. Evidence for the relative ages of the cherts and Jurassic sediments is found in the fact that the chert series has been more severely folded, more cut by intrusives, and subjected to greater metamorphism than the tuffs and sandstones of the adjacent area. Since outcrops of one of these classes of rocks lie close to outcrops of the other it can hardly be objected here that degree of alteration is not a proper criterion by which to judge the relative ages of the two rock masses, and it is therefore concluded that the cherts are older than the sandstones and tuffs and that their age is probably Triassic.

LOWER JURASSIC BEDS.

Occurrence.—So far as is now known the rocks grouped together under the heading lower Jurassic beds are best developed along the shore of Cook Inlet from the west side of Seldovia Bay to a point halfway between Seldovia and Dangerous Cape, and along the north shore of Port Graham (Pl. XIII). Whether or not they extend west of Port Graham is not known, since that part of the coast was not visited by the Survey parties.

Character.—The beds are of fragmental deposits thought to be of volcanic origin. They vary from fine tuffs to agglomerates containing large blocks of weathered igneous rock; some cherty calcareous beds are also present. These deposits are cut by basaltic and rhyolitic dikes and are fossiliferous. The tuffs are greenish black or reddish gray in color and vary greatly in the coarseness of the fragments forming them, resembling sometimes a close-grained sandstone, sometimes a fine conglomerate. Sharp angular fragments of feldspar, both orthoclase and acid plagioclase, form a conspicuous portion of the dark varieties and are contained in a matrix consisting largely of chlorite material. No quartz was observed. The coarse tuffs also contain angular feldspar fragments, but the other constituents are more difficult to determine, since the rocks have been highly altered. Calcite and chloritic material is abundant.

These tuffs contain organic remains on which the determination of their age is based. Some of them at first glance were regarded as sandstones or possibly arkoses, but the character of the material composing them and their association with agglomerates which, although modified by the action of water, are clearly of igneous origin, indicate that they are not wholly the product of a rapidly weathered igneous land mass, but consist of the finer water-laid fragments thrown out during volcanic eruptions. A half mile or more west of the entrance to Seldovia Bay the finer-grained fossiliferous beds are overlain by other beds containing in a finer matrix large fragments of red, white, and green igneous rock, generally angular. The same sort of beds occur again a short distance to the west, interstratified with fossiliferous tuffs, and make up a considerable part of the formation. The whole time of deposition of this series of beds seems to have been one of volcanic activity. As stated in discussing the age of the cherts, the relation between the lower Jurassic beds and the cherts is probably one of unconformity. The relation to the overlying Kenai

sediments is also one of unconformity, for the horizontal Kenai beds are found in small basins of tilted and folded Seldovia tuffs at several localities on the Cook Inlet coast below Seldovia Bay. The tuffs lie in open folds (Pl. IV, *A*), whose dips occasionally are as great as 60°, and have undergone little mechanical alteration, although the chemical changes are pronounced at times. The observed strikes appear to bear little relation to one another, or rather the relation was not made out.

Age.—Evidence for the age of the lower Jurassic beds is derived from the fossils contained in them. These fossils were collected by Doctor Stanton and other members of the party under Doctor Martin's charge and the determinations were made by Doctor Stanton. They show that the beds probably belong to the lower Jurassic and that they are not exactly equivalent to the Jurassic sediments found on the west side of Cook Inlet, which are younger. A list of preliminary determinations of the fossils is here given, with the localities from which the fossils were obtained:

Field No 904.—West side of Seldovia Bay, opposite village, one-fourth mile southeast of locality No. 905.

Trigonia sp. *a*. This abundant form belongs to the section Glabræ.
Cardinia sp. *a*.

Field No. 905.—Entrance of harbor, west point, Seldovia.

Pentacrinus.
Trigonia sp. *a*.
Trigonia sp. *b*.
Myophoria? sp.
Cardinia? sp. *b*.
Pecten sp. *a*.
Pinna cf. P. expansa Hyatt.
Fragments of an ammonite of undetermined genus.

Field No. 906.—Three-fourths of a mile west of locality No. 905.

Cardinia sp.
Trigonia? sp. *a?*
Pleurotomaria (?)
Ammonite. Fragmentary imprint.

Field No 907 A.—Shore of Cook Inlet, 2 miles west of Seldovia Bay.

Cardinia sp. *a*.
Pecten sp. *b*.
Gryphæa sp.
Perna ??
Pseudomelania? sp.

Field No. 907 B.—Same locality as 907 A, but 200 feet higher.

Trigonia sp. *a?*
Trigonia ?
Pinna cf. P. expansa Hyatt.
Pecten sp. *b*.
Pecten sp. *c*.
Astrocœnia?
Arietites? sp. One fragmentary specimen, which certainly belongs either to this or to a closely related genus of ammonites.

Field No. 908.—Shore of Cook Inlet, 3 miles west of Seldovia Bay.

Pecten sp. *b*.
Pecten sp. *d*.

Field No. 909.—Port Graham 1½ miles southeast of coal mine.

Trigonia? Fragmentary imprints.
Pecten sp. *a*.
Ostrea or Gryphæa.

Doctor Stanton says of these fossils collected on and west of Seldovia Bay:

The evidence can not be considered final on account of the imperfect state of preservation, the small number of species, and the lack of definitely characteristic forms, but so far as I can judge from the present collections and from the field relations of the beds containing them it seems most probable that all of these small lots belong to one general fauna and that the age of the beds is lower Jurassic. The fossils are certainly Mesozoic and there are no species in common with the middle and upper Jurassic faunas, which are so well developed in formations of great thickness on the west side of Cook Inlet and on the Alaska Peninsula, while there are several types that are apparently older than any that are found in those faunas. On the other hand, the only reason for suggesting Triassic age is the presence of shells doubtfully referred to *Myophoria* from superficial characters, and their evidence is overbalanced by the Jurassic affinities of the other species.

KENAI FORMATION.

. The main features of the sediments comprised in the Kenai formation, as well as the distribution of the sediments themselves, have already been given in outline. (See p. 16.) This formation, consisting of partly consolidated sandstones and shales, is of economic importance because of the lignitic coal seams interstratified with its various members. As previously pointed out, it rests unconformably on the Seldovia lower Jurassic rocks.

Fossils from the Kenai beds of Port Graham and Ninilchik were described by Heer as early as 1869. The former locality was afterwards visited by Dall,[a] who collected fossils there, as well as from other localities on the north side of Kachemak Bay. The Kenai beds probably underlie the whole of the Kenai Plateau, but their northward dip carries them below sea level a few miles south of Kasilof River, and they do not appear again. These coal measures were thought by Heer to be of Miocene age, but Doctor Dall referred them to the Oligocene and gave a list of plant and animal remains collected at Port Graham, among which are both Coniferæ and broad-leaved trees, the total number of species amounting to 44. He says: "The deposit appears to have formed at the bottom of a lake."

Dr. F. H. Knowlton in the same report[b] gives a list of plant remains from the Kenai formation collected by Doctor Dall in 1895, as well as those previously known from the same region, and states that they are believed to be of Eocene or Oligocene age.

Later, in speaking of the typical Eocene strata of Chicagof Cove, Doctor Dall[c] says:

The only representative of the Eocene epoch known in Alaska previous to the Harriman Expedition was the Kenai series [formation], which had been referred by Heer to the Miocene and by others to the Eocene, but which has of recent years been recognized as Oligocene by the present writer and others.

In the same publication[d] Doctor Knowlton, after describing a collection of fossil plants from Kukak Bay, makes this statement concerning their age:

It is hardly necessary at this time to go into a history of the plant-bearing horizons of Alaska. * * * It is sufficient to state that the named species above enumerated are typical of the so-called arctic Miocene, which is now regarded as of the age of the upper Eocene. The species described in this paper as new are in various ways allied to forms characterizing this horizon, and I do not hesitate to refer this collection to the upper Eocene.

The Kenai beds were studied by Mr. Stone in his investigation of the lignites of Kachemak Bay and Port Graham, and their detailed description will be found in his report, which forms part of this bulletin (pp. 57–59).

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[a] Dall, W. H., Report on coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, pp. 787 and 842.
[b] Op. cit., p. 876.
[c] Alaska, geology and paleontology: Harriman Alaska Expedition, vol. 4, p. 101.
[d] Ibid., p. 162.

IGNEOUS ROCKS.

CLASSIFICATION.

The igneous rocks on the Kenai Peninsula are practically confined to the southwestern portion of the Kenai Mountains, which in the vicinity of Seldovia are largely made up of them. The most abundant of these are diabases associated with the cherts, both of which are cut by porphyry dikes. Gabbro is reported from the same region but was not observed by members of the Survey parties in 1904. The diabases have been greatly sheared and otherwise altered, so that their true nature is sometimes in doubt. Besides the diabase and other massive eruptives of the Kenai Mountains there are igneous rocks in the Seldovia region associated with the sediments of the lower Jurassic tuffs. Whether or not there are any extruded or intruded igneous rocks interbedded with the Seldovia sediments has not been determined, but the beds are cut by dikes of igneous rock, some of which are rhyolitic and some basaltic in character. In the northeastern part of the Kenai Mountains the Sunrise formation is cut by dikes of light-colored granite.

DIABASE.

Diabases are observed wherever the cherts occur, having been found at numerous localities from Port Graham to Aurora. They extend into the mountains east of Seldovia, and with the cherts are the only rocks seen there. They were examined by Palache and described in the account of the Harriman Expedition by Emerson, who states that with the cherts of Halibut Cove "are associated intrusive masses of diabase, much crushed and altered, showing in places a distinct spheroidal structure, the surface of the spheroids being largely covered with minute spherulites."[a] Judged by the thin rock section the samples collected at Halibut Cove are not from the most typical diabase exposures. Specimens obtained at a number of localities from Seldovia to Yukon Island have been examined and show a coarse green diabase with long lath-shaped plagioclase feldspars and crystals of pale-green pyroxene and brown hornblende. The pyroxene and some serpentinous material, apparently an altered glass, make up the larger part of the filling between the feldspars. Long needle-like apatites are numerous, while biotite is less so. Ilmenite, largely altered to leucoxene, is found in all sections. Secondary calcite is often present. Dark patches of fine-grained rock are sometimes seen in the field exposures, which proved to consist of small scattered olivine crystals, somewhat altered, in a felty groundmass of fine lath-shaped feldspars. An opaque ore, probably magnetite, is disseminated through the rock, and its decomposition products, giving the section a reddish cast, show the advanced alteration.

Diabase predominates very greatly over the associated cherts, which were much disturbed either by its intrusion or by subsequent faulting. In the course of a day's tramp extending several miles into the mountains southeast of Seldovia no other rocks were seen. The exposures show that the whole mass has been subjected to extensive movements and that while the cherts responded to distorting forces by a folding of the beds the diabases yielded by fracture and movement of the blocks thus formed, so that some outcrops look like an altered giant conglomerate or a pile of rounded bowlders whose slickensided surfaces often have a mirror-like polish. If the Triassic age of the cherts is established and the diabases are extrusive rather than intrusive the time of eruptive activity is fixed; if, however, the diabases are intrusive there are no data at hand by which their age can be determined, but they took part in at least the later movement affecting the Kenai Mountains, before the deposition of the Seldovia Jurassic beds, and are therefore older than that movement.

[a] Alaska, geology and paleontology: Harriman Alaska Expedition, vol. 4, p. 26.

GABBRO.

The only data regarding rocks of this character are those collected by Becker,[a] whose note on them is here given:

A gabbro occurs at the southerly bounding wall of the Grewingk Glacier, on Kachemak Bay. The structure is granular, and the ferromagnesian silicates are olivine and augite. The former predominates, but is largely converted into serpentine. The feldspars in this rock are so clouded with decomposition products as not to be capable of identification. Doubtless fresher specimens might have been collected in the neighborhood. These were taken at the glacier wall on account of the relations of the glacier to the disintegration of the mass.

DIKES.

Reference has been made in a number of places to the different dike rocks on the peninsula. Dikes of one kind or another are known to cut all the different rock formations except the Kenai. Those recognized so far belong to the more acidic igneous rocks and include granite, dacite, porphyry, and rhyolite. As regards their distribution it may be said that they are much more numerous in the southern than in the northern part of the peninsula and that if they are present at all in the central part it is in only a few places. Those of the Seldovia region will be considered first.

Dacite-porphyry dikes.—Reference is again made to the report of the Harriman Alaska Expedition for a description of these dikes. Speaking of the cherts and diabases of Halibut Cove, Professor Emerson [b] says:

The series is cut by a group of conspicuous light-colored porphyry dikes, standing nearly vertical, parallel, and 20, 10, 50, and 60 feet in width, respectively. Under the microscope these dikes proved to be much altered dacite-porphyries, showing phenocrysts of embayed quartz, acid plagioclase, much altered to calcite and kaolin, and occasional orthoclase in a granular to granophyric groundmass of quartz and feldspar. Chlorite is sparingly present throughout the rock, but the bisilicate from which it was derived could not be determined. The dikes are quite coarsely porphyritic near their centers, but toward the contact with the cherts become almost aphanitic. The cherts are whitened for a few inches from the contact, but not otherwise altered.

Diabase dikes.—A small diabase dike, about 3 feet thick, was found cutting Jurassic tuffs at a point 2 miles west of the entrance to Seldovia Bay. It is fine grained, grayish green in color, and is made up of lath-shaped plagioclase feldspars, the interspaces being filled chiefly with green chloritic material. Small, nearly colorless crystals of pyroxene are also present, as is considerable magnetite. Occasional small spherulitic feldspar aggregates are seen scattered on the surface of a hand specimen.

Rhyolite dikes.—Only one small dike of rhyolitic rock was observed, about 2 inches thick, and this also occurred in the Seldovia formation. The hand specimen shows a dark, cryptocrystalline, almost glassy groundmass, thickly strewn with small angular fragments of quartz and feldspar. Under the microscope both quartz and feldspar are seen occasionally to have their crystal forms well developed. Orthoclase and acid plagioclase are present but somewhat altered.

GRANITE.

No igneous rocks were found in place between Resurrection Bay and Turnagain Arm. On the north side of Turnagain Arm, however, the Sunrise series is cut by dikes of light-colored granite, whose fragments appear frequently in the stream gravels. Bowlders of granite are occasionally found in the gravel deposits of the Sixmile drainage basin. Two or three large bowlders of a more basic igneous rock, diabasic in character, were also seen. In the Resurrection Creek drainage basin a greater number of granite bowlders were observed during the season's work than in the region lying farther east; nevertheless they are still far less important, both in variety and quantity, than in the gravels west of the Kenai Mountains, as observed

[a] Becker, G. F., Reconnaissance of the gold fields of southern Alaska, etc.: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, p. 47.
[b] Alaska, geology and paleontology: Harriman Alaska Expedition, vol. 4, 1904, p. 26.

about Skilak Lake, Kenai River, and the beaches of Cook Inlet at Kenai. The occurrence of granite in these localities will be taken up again in the description of the gravel deposits.

According to Mendenhall, whose most careful study of them was made in the vicinity of Portage Bay, the members of the Sunrise formation are intruded by igneous dikes, chiefly aplitic in character, but more basic in at least a few places. The writer's failure to find such dikes in the mountains southwest of Portage Bay and the fact that dikes of that nature are present in the Crow Creek neighborhood suggest that they may be of local occurrence. It is evident, however, that occasional dikes in the region visited might escape observation in a reconnaissance survey. The bowlders along Crow Creek, while very light in color, are generally of granite rather than aplite and are practically unaltered, showing that they were intruded after the folding of the Sunrise "series" was nearly if not quite as far advanced as at present. The light-colored granite dikes are very conspicuous where they occur, cutting large exposures of the darker slates and arkoses, and may often be recognized at a considerable distance.

The present knowledge of these igneous rocks is not sufficient to determine what relation, if any, they bear to the origin of the gold deposits, nor is their age known further than that they were intruded after the sediments of the Sunrise formation had been folded and more or less altered.

SURFICIAL DEPOSITS.

CLASSIFICATION.

The surficial deposits of the Kenai Peninsula may be divided into two general classes—deposits laid down in water, such as streams, lakes, or the sea, and deposits laid down by glaciers and more or less modified by the action of water. Some of the deposits of the two classes may be so closely related to one another or so similar in appearance that it is difficult to draw any sharp line between them, if it is possible to make any distinction at all. Immense deposits of gravel, sand, and clay occupying the valley floors of all the larger streams and also extending into the valleys of the side streams form one of the conspicuous topographic features of the region south of Turnagain Arm. Far more extensive, though generally less noticeable except along the streams and the shores of Cook Inlet, is the Kenai gravel sheet—the gravels and sands covering the highlands and flats west of the Kenai Mountains. These last-named deposits differ somewhat in composition and appearance from the valley gravels, but were probably laid down during the same period and to a certain extent under the same conditions. Near the mountains and in the valleys both have been more or less modified by glacier and stream action. For convenience in description and to distinguish them from the deposits of the present streams the deep gravels above the streams will be referred to as high or bench gravels.

WATER-LAID DEPOSITS.

High gravels.—Within the mountain area high terraces or benches are most prominent in the valleys of Sixmile and Resurrection creeks, around the lower end of Kenai Lake, and in Kenai River Valley between the two lakes. High gravels are also present but less noticeable along the streams emptying into Turnagain Arm. Between Canyon and Quartz creeks and on Resurrection Creek they reach elevations of 1,500 to 1,600 feet above sea level. The surface of the gravels is not horizontal, but slopes gently toward the middle of the valley from either side and downstream as well. On the benches of some streams, notably Canyon, Juneau, and Seattle, numerous small, marshy areas surrounded by spruce timber or alders mark the filled-in basins of former ponds. Though such open spaces are always wet, they are

usually followed by trails, since the difficulties of forcing a way through the thickets are thus avoided.

The gravels were laid down in an old valley at a time when, as will be shown later, the land stood at a lower level with reference to the sea than at present. Their thickness, therefore, is not uniform, but depends on the surface form of the underlying rock floor. Streams have cut channels through them and in many places now flow in canyons whose walls are high banks of gravel. The gravel banks at the mouth of Cooper Creek measure about 200 feet from the bed of the stream to their top. Their base is not exposed, and even if it were this measurement might not represent their original thickness, for gravel benches around the lower end of Kenai Lake reach an elevation of 500 feet above the water level. Kenai Lake itself is due, in part at least, to damming of the old valley by these gravels, and it therefore follows that the base of the deposits is considerably below the surface, possibly below the bottom of the lake. At Sixmile Point, on Resurrection Creek, the top of the gravels is between 300 and 400 feet above the stream or about 1,000 to 1,100 feet above sea level. Similar deposits are cut by Sixmile Creek and other streams. Near Mills Creek the high gravels have been cut into a series of sharply-defined terraces from 10 to 30 feet high, extending from Canyon Creek to the western valley side. Gravels occur on the mountain sides west of Quartz Creek on Turnagain Arm nearly 2,000 feet above tide. There are also benches in some valleys, such as that of East Creek in the Resurrection Creek basin, where the gravels reach an elevation of 3,000 feet, but these were probably deposited along the margins of glaciers that have since disappeared.

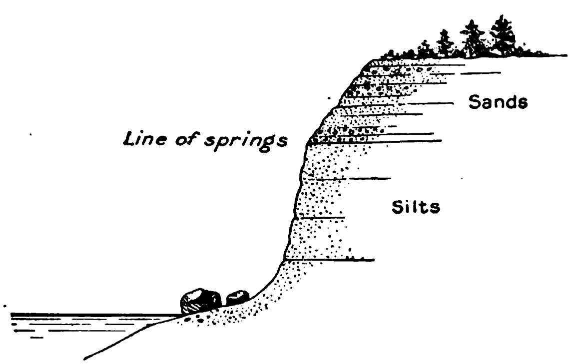

FIG. 2.—Diagrammatic sketch, showing relations of sands and silts at Kenai.

These deposits consist of washed gravels, sands, and clays. The gravels may be sandy, clayey, or ferruginous, and are made up in large part of fragments identical with the rocks of the neighboring hills. There is, however, a small percentage of granite and of some basic igneous rock which was not found in place and which may have come from a source outside the valleys where it occurs. One evidence of this is the fact that the amount of this material increases toward the west, from the head of East Fork to the inlet. All the rock fragments are more or less waterworn, and the smaller pieces are well rounded. Locally, also, they are strongly cemented with clay or iron oxide.

The sands contain a much greater proportion of flat scales of slate and arkose than of quartz, and sometimes show cross-bedding. At various places on different creeks sands of this nature, overlain by tough clays, carry a large amount of water. They are not firmly packed, and cave in continually when the attempt is made to sink a shaft in them. Since they carry no gold and it is difficult to handle the water, prospectors rarely try to penetrate them. Undoubtedly many of these sand beds are in fact stream deposits.

Most of the clays are bluish or gray in color. They usually contain some gravel and are really very fine sand or rock flour—a product of grinding by glacier ice, which gives the milky look to the waters of numerous streams on Kenai Peninsula and to Kenai Lake.

The deposits constituting the Kenai gravel sheet are continuous with the high-valley gravels and differ from them in that a large part of the material is finer and that there is a much larger percentage of fragments not derived from the Kenai Mountains. They cover the whole area between Cook Inlet and the foothills, but, except where they form terraces or are cut by streams, are generally obscured by overlying moss or brush. High banks of gravel confine Kenai River (below Lake Skilak) but decrease in altitude toward the west. At Kenai the bluff on which the town was built is between 75 and 100 feet high. A bluish-black silt containing some gravel forms the lower two-thirds of the bluff and is overlain by sands and gravels. This upper third is often firmly cemented with iron oxide and resembles a weathered ferruginous sandstone. The contact of silts and sands is distinctly shown by the outline of the bluff, for the silts stand at a higher angle than the sands (fig. 2), by the difference in color, and by a line of springs whose waters have streaked the silts with iron stains. It is evident that the ground water seeps down through sands and gravels to the less porous silts and then follows the contact until it finally emerges in springs. Granite forms a large proportion of the beach gravel, and also furnishes most of the numerous bowlders strewn along the shore. These angular bowlders or blocks reach diameters as great as 8 to 10 feet and are evidently not all derived from the same source, since they represent a variety of granites. Similar granites are found in the valley of the Sushitna, but are not known in the Kenai Mountains. It is therefore probable that their source must be sought somewhere to the north rather than on the peninsula.

The depth of these gravels was undetermined, for at no point visited by the writer had streams cut through to the underlying rock. Such measurements could probably be made at Cape Kasilof, where the northward dipping Kenai beds rise above sea level, or at other points still farther south, although there is reason to believe that the thickness decreases in that direction.

This gravel sheet has been referred to the Pleistocene and is undoubtedly connected with the northward retreat of the ice sheet presently to be described.

Stream deposits.—By stream deposits are here understood the sands, gravels, or clays laid down by a stream in its channel. Such deposits occur on all the streams of Kenai Peninsula and differ from the high gravels principally in that they are less continuous in horizontal extent; that their bedding is more imperfect; that in general the fragments are less worn, and that they are due in part to the weathering of the country rock which has taken place since the high gravels were laid down. Their most conspicuous portion is the surface wash, consisting of angular fragments varying in size from coarse sand to bowlders 2 feet or more in diameter. Such wash is without lines of bedding and usually has a thickness of 2 to 10 feet, but occasionally reaches a thickness of 15 or 20 feet. This deposit rests at times directly on the bed rock, but may overlie other gravels. Here and there small basins contain well-stratified deposits of fine gravel, sand, or clay. These include some of the "quicksands" mentioned in describing the high gravels. When a stream is cutting through bench gravels and has not yet reached bed rock, well-stratified newer stream gravels are not readily distinguished from the older deposits on which they rest.

GLACIER DEPOSITS

Surficial deposits due to valley glaciers are so closely associated with those laid down by streams that there is sometimes difficulty in determining which factor was more important in a given case or to which class a certain deposit should be referred. Undoubtedly both ice and water have worked together in many places and the deposits are to be regarded as due to the joint action of both. One of the characteristics of débris left by melting glacier ice is that, where unmodified by water currents, the fragments lie in confused heaps, just as they were thrown down, and that there is little or no separation of fine from coarse material. The best example of purely

glacial deposits seen by the writer is in the middle valley of Crow Creek. An old terminal moraine stretches across the valley at this place, and its character has been well brought out by the cut made through it to reach the gold-bearing gravels of the basin above. This moraine is made up of angular blocks of rock, all of which are probably derived from the immediate region. Above and below are basins of stratified gravels and sands deposited by water. The débris of the moraine was apparently thrown down during a period in which the ice front was stationary, allowing the rock load to accumulate in front of the glacier, or possibly the moraine may be due to a pushing forward by the advancing ice of the loose material on its bed. After the ice retreat this moraine persisted as a dam, behind which the stream was ponded, and thus fine gravel and sand could there come to rest. Considering the former wide distribution of valley glaciers it is remarkable that more moraines like that of Crow Creek were not observed. This apparent absence may be accounted for on the supposition that the glacier deposits have been modified by stream action or concealed by the high gravels.

Another class of deposits due to glaciers but modified by water includes the sand and gravel plains extending outward from the ice front. Along the streams the plains are at some places miles in length, as in the valley of Resurrection River. The floors of Glacier, Twentymile, and Portage creeks and of Glacier River furnish good examples in the Turnagain Arm region, as do also the flats at the head of Skilak and Tustumena lakes farther south. The Kenai gravel sheet and the high gravels of the Kenai Mountains have been described as water-laid deposits, but their material was largely the product of glacial erosion and was laid down in front of the retreating ice, the silts found in many localities around the inlet representing the finer offshore deposits.

GEOLOGIC HISTORY.

DEVELOPMENT OF TOPOGRAPHY.

GENERAL STATEMENT.

A study of the general surface features of Alaska has led to the recognition of four well-marked geographic provinces,[a] which, named from south to north, are as follows: The Pacific Mountain system, including numerous near-by parallel mountain ranges adjacent to the Pacific along the whole southern coast of Alaska; the Central Plateau region, a broad central zone the axis of which is followed by Yukon River and which includes the drainage of the greater part of Alaska and Yukon Territory; the Rocky Mountain system, including several mountain ranges and forming the westward continuation of the Rocky Mountains of the United States and Canada; and, finally, the Arctic Slope region, including the greater part of Alaska north of the latitude of Cape Lisburne, or, more accurately, all the region north of the Rocky Mountains.

Kenai Peninsula lies in the first of these provinces (the Pacific Mountain system), and the mountain range constituting the axis of its mass is one of the numerous ranges to which reference was made. Although much remains to be learned concerning the development of topography in this province, for as yet only the most prominent features are known and these in an imperfect way, it is possible to give some account of the events which occurred.

FORMATION OF PENEPLAIN.

After the deposition of Mesozoic sediments, but probably not till post-Kenai time, came an uplift which subjected the region to some further alteration, as is shown by the folding of the younger sediments, and began or possibly merely continued a long

[a] Brooks, Alfred H., The geography and geology of Alaska: Prof. Paper U. S. Geol. Survey No. 45, 1906.

A

B

PANORAMIC VIEW FROM HEAD OF RESURRECTION CREEK.

Looking east and south. Photographs are taken from an elevation of 5,000 feet and show the accordance of summits in the Kenai Mountains. The average elevation is between 4,000 and 5,000 feet above sea level.

period of erosion, which resulted in the reduction of the then existing land mass almost to a plain at sea level. This plain is indicated by the nearly uniform level of the tops of Kenai Mountains. Standing on one of the hills about the upper end of Resurrection Creek, at an elevation not far from 5,000 feet, and looking eastward over the mountains of the interior peninsula, one sees their ragged peaks scattered before him in apparent confusion, but all rising to nearly the same altitude. Here and there a peak projects slightly above the general level or sinks below it, but at a distance the resultant effect on the eye is a horizontal line. (See Pl. V.) This plain is the southern continuation of that observed by Schrader and Spencer in the Chugach Mountains north of Prince William Sound and called the Chugach Plateau. As stated by Spencer:[a]

> The Chugach Plateau is considered to have originated in the uplift of a base-leveled land surface, and from the fact that this feature of erosion has been found to bevel the edges of folded and upturned lower Cretaceous strata, its age is considered to be late Mesozoic or Tertiary.

UPLIFT AND EROSION.

After the long period of erosion came another uplift, which renewed the cutting power of the streams and gave them opportunity to deeply trench the old plain. Indeed, this period continued so long that the trunk streams were not only able to cut their channels to sea level, but were permitted to widen them extensively, while the inter-areas were carved into a complicated system of sharp ridges and steep, narrow gulches. How much the plain was lowered during this process is not known, but no flat-topped mountains were seen, and the sharpness of nearly all ridges would indicate that they are now somewhat below the level of the land surface which conditioned their altitude. This interval of valley making possibly took place at a time when the land stood at a higher elevation than now, for the valley floors of many streams lie well below the present sea level. It should be stated, however, that this condition might be the result of some other agency, as glacial erosion, which has been mentioned in explanation of the deep fiords of Prince William Sound.[b]

BEGINNING OF GLACIATION.

The period of subaerial erosion was interrupted by a change of climatic conditions and the beginning of a period of extensive glaciation in which the valleys were still further modified and reduced practically to their present forms. This alteration consists mainly in a deepening and straightening of the existing valleys, most of which occurred during the advance and maximum development of the ice fields. The resulting débris was spread before the ice front, and on the retreat of the glaciers to the higher altitudes covered the valley floors as well. The influence of glaciation on the topography will be more fully considered in later paragraphs.

DEFORMATION.

Finally another uplift brought the Pleistocene gravels above sea level. Mendenhall[c] holds this uplift to have been differential, and cites as proof the southerly tilt of the old Matanuska River Valley and the northerly tilt of the Kenai Plateau. In the Matanuska Valley the tilting is shown by the position of the gravels, but more clearly by the high gradient and recent cutting of the river, which now flows in a narrow channel cut in an old broad valley. The floor of the old valley emerges from beneath the gravels of the lower river about 20 miles above the head of Knik Arm, but at

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[a] Spencer, Arthur C., Pacific Mountain system in British Columbia and Alaska: Bull. Geol. Soc. Am., vol. 14, 1903, p. 120.

[b] Schrader, F. C., and Spencer, A. C., The Geology and Mineral Resources of a Portion of the Copper River District, Alaska, 1901, p. 81.

[c] Mendenhall, Walter C., A reconnaissance from Resurrection Bay to Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, 1898–99, pt. 7, p. 333.

Glacier Point, 50 miles farther up, stands from 400 to 500 feet above the river, giving the old valley floor a slope of nearly 10 feet to the mile.

The evidence for the production of this tilting during post-Glacial time is based on the correlation of gravels at the head of Matanuska River with gravels near its mouth. Mendenhall suggests that Turnagain Arm represents an axis of minimum uplift toward which both the Kenai Plateau and the old Matanuska Valley were made to slope. It is seen that the accuracy of the determination of the suggested time of tilting depends on whether or not the Cook Inlet and the Copper River Plateau gravels at the head of Matanuska River were laid down at the same time and elevation, since if deposited at about their present elevation the present river channel may have been largely cut before the ice mantle appeared. A simultaneous tilting of the areas north and south of Turnagain Arm appears reasonable, but if occurring in post-Glacial time would offer a most serious objection to the suggestion of block faulting as explaining the relation between the Chugach and Kenai plateaus, for it is inconceivable that erosion so great as that involved in that suggestion could take place in so brief a period. The uplift which began after the ice retreat and lifted the Pleistocene gravels to the position now occupied is so recent that many of the streams have not yet cut through the gravel deposits in more than a very small part of their length and are still actively engaged in that work.

RELATIONS OF KENAI AND CHUGACH PLATEAUS.

At least three explanations may be suggested for the relation of the Kenai Plateau to the higher Chugach Plateau, which is indicated by the accordant mountain tops of eastern Kenai Peninsula:

1. That the Kenai was laid down during a period in which the then partly dissected Chugach Plateau was submerged and that all traces of the deposit have since been removed from within the mountain area, the portion outside the mountain area having been folded and having its surface planed down to the present level.

2. That the Kenai sediments were deposited on the Chugach base-leveled surface before its dissection, during a period in which the area was totally or partially submerged, the difference in elevation of the present Kenai Plateau and the Chugach Plateau (from 3,000 to 4,000 feet) resulting from displacement along a fault which marks the western boundary of the Kenai Mountains.

3. That during the deposition of the Kenai sediments the partly dissected Chugach Plateau represented by the Kenai Mountains stood above sea level, erosion of that land mass furnishing some part of the Kenai beds.

Taking up the first hypothesis it may be said that evidence collected by various geologic workers in Alaska and the neighboring Canadian possessions seems to show more and more clearly that all or nearly all of the region was base-leveled during Tertiary time, and that the present topography has originated since that base-leveling took place. Kenai beds are found to have undergone such leveling in regions whose planation is provisionally correlated with this general base-leveling, the evidence indicating that the planation does not represent a stage of erosion after the original plane had been extensively dissected, but that the general base-leveling took place later than Kenai time. If, therefore, the time when this erosion took place is established as post-Kenai the first hypothesis fails.

With reference to the second hypothesis it must be said that no direct evidence was found to indicate the occurrence of faulting along the western face of the Kenai Mountains. Such faulting not only would be of considerable maximum displacement, amounting to not less than 4,000 or 5,000 feet, but would extend in the direction of its strike for possibly 200 miles. This hypothesis involves also the removal by erosion from the mountain area of a volume of rock which, although probably in no way comparable to that carried away during the long period of base-leveling,

is yet greater than the quantity necessary to fill the present valleys and restore the land surface approximately to a plane, for it includes what was removed from the base-leveled surface and possibly from the overlying Kenai deposits as well.

It is not necessary, however, to suppose that the Kenai beds ever extended over that portion of the Chugach Plateau that is preserved in the Kenai Mountains, which may have formed a very low land surface during Kenai time. This hypothesis, according to which the Kenai Plateau is a fault block depressed with reference to the Kenai Mountain area, also offers one explanation for the northward slope of the plateau surface, since such a block might be displaced unequally at the north and south extremities and thus produce the tilting which, so far as now known, took place only on the west side of the peninsula and did not affect to any great degree the Kenai Mountains. It is possible that future study may show the mountain area to have been tilted also, but at present it appears probable, from the very meager evidence at hand, that if the Chugach Plateau in Kenai Peninsula dips at all it is toward the south rather than the north. Such an explanation of the tilting of the Kenai Plateau may meet with difficulties when the Matanuska Valley tilting is studied, yet it should be borne in mind that the two movements may have different causes, and if so must be accounted for in different ways.

The third hypothesis which at first thought appears the simplest, also meets with objections. This hypothesis represents the Kenai beds as deposited during a period in which the Kenai Mountains were above sea level and possibly stood at about their present elevation. Kenai sediments were deposited offshore and their gravels, sands, etc., were supplied largely by weathering of the neighboring land mass. Either the Kenai was never laid down within the mountain-area valleys, or if deposited has since been removed. The continuance of a land surface possessing such high relief as that seen in the Kenai Mountains from early Tertiary time to the present is possible, but the great objection to this hypothesis is the one already raised—that a preponderence of evidence now favors a later age than Kenai for the Chugach Plateau, that is, the Chugach Plateau was not produced till after the sandstones, shales, and lignites of the Kenai formation were laid down and folded.

Of the three hypotheses presented the second has something in its favor, but as yet only a few of the facts bearing on it are known. If the present topography originated as has been outlined, by dissection of a former land mass which was first base-leveled and then elevated several thousand feet above sea level, the first and third hypotheses are impossible unless either the period of planation took place before Kenai time or the planation of the folded Kenai beds took place after the Chugach Plateau was formed, both of which conditions appear to be contrary to fact. A presentation of various explanations for the accordance of summits in alpine mountain systems has recently been made by Mr. Daly [a] in which it is urged that a number of causes work together in such regions to produce that result. While the truth of the peneplain hypothesis when applied to certain topographic regions is not questioned, the explanations (isostatic adjustment, differential weathering, glaciation, etc.) offered for the forms of alpine mountains are opposed to the peneplain hypothesis in that they do not require the occurrence of a period of planation before the mountain uplift begins. There can be no doubt that most, if not all, the causes suggested are operative in some degree, but it is not possible now to say what part each took in the topographic development of the region under discussion.

GLACIATION.

While glaciation and its influence in determining topographic features might more properly be considered an incident in the general development of land forms, its importance on Kenai Peninsula is sufficient to make its separate treatment desirable.

[a] Daly, Reginald A., Summit levels among alpine mountains: Jour. Geol., vol. 13, No. 2, 1905, p. 105.

Several localities where permanent ice masses occur have already been mentioned, and others will be seen by referring to the map. Among the more important are Portage Glacier and the near-by glaciers on Twentymile Creek and Glacier River; also the glaciers on Lake Skilak, Lake Tustumena, and Kachemak Bay, as well as the smaller ones on Snow River, Resurrection River, and the east side of Resurrection Bay. Grewingk Glacier, on the south shore of Kachemak Bay, was visited by Dall, and later, at the time of the Harriman Alaska Expedition, was revisited by Dall and G. K. Gilbert. Mr. Gilbert's description is found in the account of that expedition. Only one or two of the glaciers mentioned were visited by the Survey party in 1904. At present most, if not all, of them appear to be in a state of retreat.

The present glaciers represent only a small remnant of the great system of ice rivers which once moved west, south, and east toward the sea from the valleys of the Kenai Mountains. Almost any valley one might choose gives evidence of former ice occupation. (Pl. VI, *A*.) Hanging valleys, from which streams plunge over steep cliffs to the main valley below, are seen in many places. (Pl. VI, *B*.) Along both shores of Turnagain Arm outcrops striated and rounded by moving ice are found where Portage Glacier, reenforced by ice streams from Twentymile Creek, Glacier River, and other valleys opening on the arm, flowed westward to unite with the much greater streams from Sushitna and Matanuska valleys. The valley of the Kenai-Snow system was the bed of an ice river, of whose greatly diminished mass there now remains only the glaciers of Snow River and Lake Skilak. North of Lake Skilak, at the lower end of the middle river, hilltops 1,200 to 1,400 feet above sea level are domed and beautifully polished, giving evidence of the minimum thickness and the erosive power of the ice. Here the striations, which, aside from local variations, have in most places about the same directions as the trends of the valleys, run across the ridge in a direction N. 10° W.

The extent of the ice mantle of which the Kenai glaciers formed a part is not fully known. It is probable, however, that the mountain areas inclosing the lower Sushitna Valley (these include the Alaska Range and the Chugach and Talkeet mountains) were centers of accumulation from which ice streams filling the valley converged toward Cook Inlet. In 1902 Brooks and Prindle found evidence of glaciation (perched bowlders and striæ) on isolated hills in Sushitna Valley 2,500 feet above sea level. Similar evidence was found along the front of the Alaska Range, while in Mantanuska Valley Mendenhall determined from the occurrence of scored and polished rock surfaces that the ice had a thickness of 3,000 to 3,500 feet. Ice streams from the valleys united in a broad sheet at the foot of the mountains in some such way as ice streams now unite at places along the Pacific Coast farther southeast. How much of Cook Inlet was occupied is uncertain, but the granite blocks on the beach at Kenai indicate that it extended at least as far southward as that locality. We may, therefore, think of the former ice mantle on western Kenai Peninsula as made up of numerous streams descending from the elevated mountainous country to the east and flowing westward to unite with one another and the broad ice stream moving southward through Sushitna Valley and Cook Inlet. Such ice sheets, lying just outside the mountains, have been called piedmont glaciers, in distinction from the alpine glaciers of the mountain valleys.

All these evidences of the former ice mantle are also proofs of climatic conditions different from those prevailing on Kenai Peninsula nowadays. More snow fell in the cooler than was melted in the warmer seasons, and the accumulating ice gradually flowed away from the principal centers, scouring out the valleys and bearing with it the débris which had been plucked from its bed or had fallen on its surface, and which now forms a large part of the high benches and broad sheets of gravels, sands, and silts already described.

A. VIEW DOWN EAST CREEK TOWARD RESURRECTION CREEK.

Good example of a glaciated valley.

B. HANGING VALLEY NEAR THE HEAD OF JOHNSON CREEK.

Photograph taken late in June.

SUMMARY.

The events just described as important factors in producing the land form, as seen on Kenai Peninsula, may be summarized as follows: During a time now thought to be later than that in which the coal measures of the Kenai (upper Eocene) were laid down the land mass then existing was reduced by erosion almost to a plain. This plain probably stood at an elevation very little above sea level, but later was raised to a considerable height, and thus allowed the processes of erosion, which had almost ceased, to be vigorously renewed. Erosion continued so long that the streams were not only enabled to thoroughly dissect the old plain, but were also permitted to cut their channels deeply and broaden their valleys. This period of erosion was necessarily a long one, and in it the major features of the present topography were established. One interruption occurred, however, when the advancing ice mantle moved down the valleys and out over the lowlands, but even then the manner and intensity of erosion only were changed. Valleys were straightened and broadened and the resulting rock waste was spread out before the ice front. Finally, the retreat of the ice was followed by land elevation and a renewal of stream activity, which left the land forms as they now are.

ECONOMIC GEOLOGY.

GOLD.

PLACER DEPOSITS.

GENERAL STATEMENT.

It has been shown that the Russian-American Company's efforts to develop both the gold and coal resources of Kenai Peninsula met with failure. As Doroshin himself states in his account of the two seasons' prospecting carried on for the company, his labor had no other effect than to chill the ardor of the directors for gold mining, so that it was not until long after American occupation that his belief in the existence of profitable gold deposits was justified, and even now none of the streams on which his work was carried on have produced gold in commercial quantities.

During the first few years of mining excitement following the discovery of gold on Resurrection Creek in 1895, more or less prospecting was done on nearly all the creeks of the Kenai River drainage. Other creeks on the west side of the peninsula were also prospected, but development work has been confined chiefly to the region of Turnagain Arm. Gold is widely distributed and is found in nearly all the surface deposits, the high bench gravels, stream gravels, glacial débris, and some of the sediments west of Kenai Mountains. Except at one place, however, it is only in the stream channels, where concentration has occurred, that the deposits have sufficient value to permit their exploitation with profit under the methods used. Gold is here derived, with little doubt, from the high gravels and glacial débris as well as from the rock waste of recent erosion. Since the real beginning of mining in 1895 the Turnagain Arm field has probably yielded over a million dollars, but it has been found impossible with the data at hand to give a more satisfactory estimate of the total production.

As has just been stated, the gold-bearing gravels which have made the Cook Inlet region important as a producer of the precious metal are found chiefly in the valleys of the streams emptying into the eastern half of Turnagain Arm. There are, however, less productive gravels at a number of localities, notably in Kenai River Valley, in one or two streams flowing into the eastern end of Lake Tustumena, and at Anchor Point.

A brief outline of the placer gold field is here presented to bring out some facts not directly evident from the map (Pl. II), while the more detailed description of indi-

vidual streams will follow. For convenience the four principal drainage basins where gold-bearing gravels are exploited will be referred to by the names of the trunk streams—Resurrection, Sixmile, and Glacier creeks and Kenai River. The first three are the important streams in what may be called the Turnagain Arm field, all of whose producing creeks are included in a rectangular area, 25 miles from north to south, and 20 miles wide, with its center situated about 5 miles southeast of Sunrise.

Resurrection Creek is the westernmost productive stream flowing into the south side of Turnagain Arm. Together with Bear Creek (which is properly a part of the same system although the two do not unite) it drains an area 21 miles long and 8 to 9 miles wide, comprising about 175 square miles. The side streams, with two or three exceptions, are short, the upper portions of the narrow valleys being above timber line. The mountains, though steep and at times covered with loose blocks and smaller débris, are much less rugged than any others seen during the season.

Sixmile Creek, which enters the arm 8 miles up from the mouth of Resurrection Creek, is formed by the union of two large branches, Canyon Creek and East Fork (Pl. VII, *B*), and drains an area of approximately 250 square miles. The valleys of the two branches, as well as that of the trunk stream, are broad and are floored with heavy deposits of gravel. From the forks of the stream to the town of Sunrise, at its mouth, the distance is 10 miles. Mills Creek, the most important tributary, joins Canyon Creek 8 miles south of "the forks." A majority of the small streams which compose this drainage system, like those of the Resurrection Creek system, occupy steep narrow valleys, but a decided difference between the two regions is found in the character of the topography, for the smooth rounded contours of the mountains west of Resurrection Creek here give place to the rugged outlines that characterize the whole eastern portion of the peninsula.

Glacier Creek flows into the north side of Turnagain Arm 9 miles east of Sunrise. It is about 8 miles long and flows in a broad flat-bottomed valley, whose floor is covered with a heavy growth of timber. The whole drainage area comprises about 45 square miles and is a region of very rough topography. Crow Creek is the most important tributary.

Other streams flowing into the arm have been prospected with little success. Their valleys are generally narrow and steep, and it is noticeable that the great deposits of gravel, such as are seen in Resurrection and Sixmile valleys, were either never extensively developed here or have since been partly removed.

A description of Kenai River has been already given (pp. 14–15).

RESURRECTION CREEK VALLEY.

Resurrection Creek.—This stream, the earliest producer of the region, flows through a broad valley floored with a thick deposit of gravels, in which, throughout the greater part of its length, the waters have cut a deep, canyon-like channel. The portion from which gold has been taken, lying between Sixmile Point and Hope, has an average grade of 66 feet per mile, the grade of the lower 20 miles being about 100 feet per mile. Bed rock has not been reached on the majority of claims, for the stream cuts the country rock at only a few places and is working principally on gravels filling an old valley whose floor formerly stood at an elevation considerably higher than its present one. These valley gravels are roughly stratified and have been penetrated in one place to a depth of 50 feet below the stream level without reaching solid rock. They consist largely of slates and arkoses from the neighboring hills, but contain, in addition, an uncertain percentage of material, chiefly granitic in character, foreign to the valley. The bench deposits have never been worked, but are known to contain fine gold. A 60-foot bank 2 miles below Palmer Creek yielded colors from bottom to top, the best pan, about 2 cents, being taken from the upper 10 feet.

A. CANYON CREEK.

Showing the steep rock walls capped with gravels, and the remains of an old wing dam and China pump.

B. FORKS OF SIXMILE CREEK.

View down east fork. A bridge crosses Canyon Creek, on the left of which is the high gravel bank. A high bench is on the left.

A. CANYON OF PALMER CREEK.

High gravel bench on the left.

B. LOWER END OF PALMER CREEK.

Showing the deep rock canyon with gravel-capped walls.

Placer mining is confined to the channel gravels, which, however, must be derived, in part, at least, from the benches. The so-called bed rock on which pay is obtained is a gray glacial clay of variable thickness overlain by from 4 to 9 feet of stream wash containing some scattered gold. One claim on the creek yielded an average of 60 cents in gold to the cubic yard for a period of five years. This average was based on the assumption that a little over 4 yards of dirt per man per day were handled. From 4 to 5 yards is considered a good day's work.

The gold is fine and smooth, usually bright yellow in color, but at times whitish, and then of lower grade. Eighteen ounces of dust sent to the assay office contained $2 in silver.

Profitable mining on Resurrection Creek has been carried on entirely with pick and shovel. The method usually employed is to divert the stream into a new channel by a dam and then wash the uncovered gravels. All the material, excepting large bowlders, is sent through the boxes and the tailings are discharged into the stream below. A hydraulic elevator introduced at a point 9 miles south of Hope to handle channel gravels was not operated successfully, chiefly owing to the insufficient water supply and many bowlders. The former difficulty can be overcome without great expense, but derricks of some kind will always be necessary to handle the large material. Bowlders 2 or 3 feet through are not uncommon, and greater ones, with diameters of 5 to 6 feet, were also noted. A dredging machine shipped to this region on one of the late boats did not reach its destination and was unloaded at Valdez, to be brought in later. It is extremely doubtful, however, if there is any locality in the Resurrection Creek Valley where present dredging methods can be employed successfully, owing to the depth of the gravels and their irregularity in both the size of the material and the manner of its deposition. Bowlders form a large proportion of the deposits.

Palmer Creek.—Palmer Creek is the largest tributary of Resurrection Creek. Its upper portion flows for 6 miles through a broad, round-bottomed valley, while its lower part occupies a steep, narrow canyon cut through rock in some places and through gravel benches in others. (Pl. VIII, *A*, *B*.) Mining has been carried on chiefly in the lower 1.5 miles of the stream and has been confined entirely to the channel gravels. The country rock includes interbedded slates and arkoses, whose cleavage strikes a little east of north and dips at a high angle. The arkoses are frequently very much jointed and in weathering do not break into small pieces as easily as do the slates, a fact readily seen on examining the stream wash. The gravels resemble the country rock in their composition, and were undoubtedly derived from it in large part, although there are a few granitic bowlders which may not be of local origin. There is a large proportion of angular fragments and no small percentage of coarse material, possibly 5 per cent being over 18 inches in diameter. At the surface the gravels were laid down without definite arrangement, but are rudely stratified below. It is said that they yield about $1 per yard of material handled, but it should be stated that from 30 to 40 per cent of the gold is obtained from bed rock.

Palmer Creek gold is coarse and heavy, usually much flattened, and smooth. It passes at $16 per ounce at the local stores. In color the gold is bright yellow, but may be whitish. Pieces of native silver weighing as much as 1 pennyweight were seen, and also some black sand, which, however, is not abundant. No fine gold is saved. The claims on this stream were originally held by single individuals, but at present the whole of the lower canyon portion, 18 claims, is controlled by one company.

Two hydraulic plants were at work in 1904, employing in all about 10 men. The season was a wet one, and at the time of the writer's visit, in July, the stream was flowing not far from 3,000 inches of water, an amount sufficient for the present needs of mining. This quantity, however, is very much increased in time of high water, and may be considerably decreased during a dry season.

The greatest difficulty met in operating these plants arises from the presence of many large bowlders, which it is necessary to move by hand at least once. They are piled in a box provided with some dumping device and hoisted from the pit by a derrick, this operation consuming about twice the amount of time spent in piping, thereby decreasing greatly the efficiency of the plant. (Pl. IX, *B.*) When too large to be handled in any other way, the bowlders are reduced to convenient size with a few sticks of powder. It is the usual practice to operate the derrick with the stream from the giant, rather than to use a separate line of pipe for that purpose. With the present methods of mining, Palmer Creek should be a producer for several years to come.

Bear Creek.—Bear Creek is the best known stream in this part of the field. It is about 5 miles long and has a fall of nearly 500 feet to the mile. Bear Creek Valley is narrower than Palmer Creek Valley, and, while resembling it in some ways, does not have the canyon features so well developed. The country rock is a succession of arkoses interstratified with bluish-black slates, the beds being so thin in one or two localities as to give to the outcrops a banded structure. These beds strike N. 20° E., or nearly at right angles to the general course of the creek, the cleavage, however, running more nearly north and south. The gravels are very irregular in distribution and are made up almost entirely of material like the country rock, but include, in addition, a few bowlders of granitic rock. In two places from 25 to 30 feet of unstratified deposits were seen. These contain a large quantity of coarse angular blocks mixed with sands and clays, the whole apparently dumped into its present position without having undergone any sorting by water. Bowlders 3 to 4 feet in diameter are plentiful. In some localities the surface wash is underlain by stratified sands and clays, which were probably deposited in small local basins, where they are sometimes found abutting against perpendicular rock faces or overlapping sloping surfaces. The hard gray clay locally underlying the surface wash and known as "glacial clay" rests on loose sands composed largely of slate particles and containing a large amount of water. It has been noticed in a few places that the rock surface above this clay is worn smooth, while below it is rough and unworn.

Bear Creek gold is lower in grade than any other from the Resurrection region. Like that from Palmer Creek, it is usually bright yellow in color, but may be whitish. Some native silver is found, and it is said that a small amount of native copper is also present. One large nugget of gold, valued at about $250, was found. The first claim staked on the stream yielded a little more than $2,000 the first year it was worked, but was not operated with profit in the following years. A second claim worked steadily, but in a small way, since the early days of Bear Creek's history has produced an average of $8 a day per man.

Two hydraulic plants have been installed on Bear Creek, but only one was in operation during the season of 1904, the other being involved in lawsuits. Although there has been sufficient water in the stream for the needs of these plants, the same difficulty with bowlders is encountered as on Palmer Creek. Bowlders are removed from the pit by derrick or cableway and are dumped at one side or carefully piled along the channel. It may be readily seen that the time lost in this way is great and that the cost of production is thereby very much increased. It can hardly be said that the future of the creek is bright, though with economical methods there are parts of the stream which can doubtless be worked at a profit.

SIXMILE CREEK VALLEY.

The area of the drainage basin supplying the waters of Sixmile Creek and its branches is nearly half as large again as that of Resurrection Creek, and is much more irregular in outline. Probably the most noticeable feature of the topography in this area aside from the ruggedness of the mountains is the great development of *gravel benches,* which appear most prominently in the valleys of Sixmile Creek and

A. CANYON CREEK.

Showing the high gravels on the right. The trestlework formerly carried a flume.

B HYDRAULIC MINING ON PALMER CREEK.

Shows the method of handling bowlders.

its two branches, Canyon Creek and East Fork. This basin contains the richest gold-bearing gravels yet found in the Turnagain Arm region, and mining operations have therefore been carried on here more extensively than elsewhere. The production of this part of the field is reported to be nearly $1,000,000, derived chiefly from Canyon, Mills, Lynx, and Gulch creeks.

Sixmile Creek.—Sixmile Creek has not been an important gold producer. It flows through a broad, flat-bottomed valley, but has not cut deep into the valley floor, so that the canyon features seen above on Canyon Creek are not here as well developed. Some mining has been carried on with fairly good results in one or two cases, but on the whole without marked success. A hydraulic plant was operated for some time on gravels said to carry about 40 cents per yard, but the work proved unprofitable and was finally given up. At present there is little or no mining on the stream.

Canyon Creek.—Canyon Creek flows for a distance of 8 miles through a narrow canyon ranging in depth from 100 to 200 feet or more, extending from "the forks" to a point just below Mills Creek. Above Mills Creek the valley is open and the waters have not yet had an opportunity to cut deeply into the gravels. A number of small lakes and considerable soft, wet ground make traveling in this part of the valley very disagreeable at times.

The country rock comprises shales and arkoses whose bedding and cleavage strike parallel with the course of the stream. In some of the narrower portions of the canyon the rock walls are seen to be capped with gravel deposits, but as a rule the

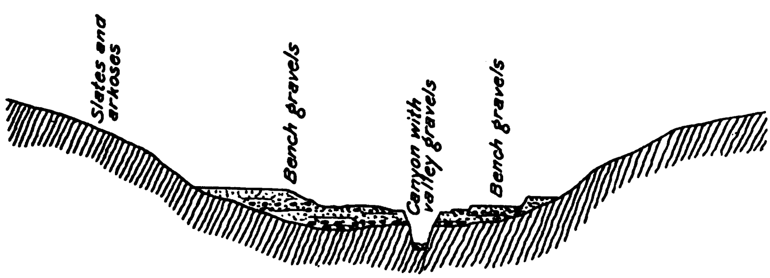


FIG. 3.—Diagrammatic sketch showing relations of creek and high bench gravels on Canyon Creek.

débris from above covers the rock faces, giving the impression that the height of the wall from the stream to the top of the bench represents the thickness of the gravels. Two principal gravel terraces at different elevations, besides a number of smaller ones, are seen below Mills Creek (fig. 3). In the localities most favorable for observing the high gravels near the stream, they were seen to have a thickness of about 50 feet, but the higher benches back from the creek may be considerably thicker. The bench gravels are made up chiefly of fragments like the country rock, but contain some material which was not seen in place south of the arm. Much of the gravel is rounded and well stratified, as is well shown in the benches near "the forks." In places it is cemented by iron oxide and gives difficulty in mining because it is not easily broken and often passes directly through the sluice boxes, carrying its gold into the dump. This gravel is locally known as "cement gravel."

The stream gravels are not stratified and the material is, in general, coarser and more angular than that of the benches. A section of gravel deposits at the flat near the mouth of Canyon Creek shows at the top from 6 to 8 feet of soil and coarse wash overlying 8 feet of sandy deposits, followed in turn by stratified clays and gravel.

The high gravels away from the channel have not been prospected, although gold is present in the high banks on the left side of Canyon Creek near "the forks," and the writer was told that a hole somewhere west of the stream showed good prospects. The only high gravels yet exploited are on the edge of the canyon, 3 miles

above "the forks" (Pl. IX, *A*). Some gold is distributed through the gravel, but the greater portion comes from bed rock, which is here smooth, but shows hummock-like irregularities, due possibly to the action of ice, or, it may be, of running water. A well-defined rock channel, 40 feet wide and 12 feet deep, was uncovered by the removal of the gravels. This channel runs in a northwesterly direction, and is 150 feet above the present channel. In this channel was a bowlder weighing probably 15 tons. The gold from the bench is flaky and assays over $17 to the ounce. The largest piece yet found there was worth about 25 cents.

By far the greater part of the product of Canyon Creek has come from channel gravels. The swift current prevents any uniform distribution of gold, but the eddies behind rock points and large bowlders give an opportunity for the heavy particles to find lodgment, and at such places very rich pockets have been found. The stream has therefore been a good one for "sniping;" that is, for working the richest spots in a small way with very simple appliances.

The most evenly distributed gold occurs in the gravels of the flat at the junction of Canyon Creek and East Fork. This ground lies immediately below the canyons of both Canyon Creek and East Fork, making it a sort of dumping ground for the two streams. At this place the best pay comes from the clay bed rock, but fine gold is scattered through all the gravel.

Canyon Creek gold is generally coarse, as would be expected from the nature of the channel and swift current; that from "the forks" is finer. One hundred and six ounces of dust and amalgam, collected chiefly from claims on Canyon Creek, lost 4 per cent of its weight after melting at the mint; 0.8 per cent of the weight was silver and the combined value of gold and silver was $17.42 per ounce. The value before melting was $16.70 per ounce.

Mining on Canyon Creek has been carried on under difficulties, arising from the narrow channel and swift current. The more extensive operations always involve the construction of wing dams to confine the water to one side of the channel while the other side is being worked out (Pl. VII, *A*). Such operations are expensive and the results are uncertain, since in more than one instance the labor of an entire season has been destroyed by high water and loss of the dams. About two years ago a hydraulic plant was placed on the bench claims previously mentioned, and has met with some success, although with the present arrangement of sluice boxes some gold is probably lost. Yet this plant furnishes the only instance in the region of the use of undercurrents for saving fine gold. A head of about 300 feet is used in sluicing. The water supply during the season of 1904 was sufficient for all needs, but there was some trouble in getting water the previous year. This abundance of water resulted from a wet season and the fact that continued cool weather in the early summer prevented rapid melting of snow on the mountains. The obtainment of water for mining purposes is, however, a question of expense rather than of supply, for the region is peculiarly fitted for hydraulic mining. If it can be shown that the high gravels carry sufficient gold to permit hydraulic mining to be carried on in a large way with profit, the importance of the Sixmile region as a gold producer would be greatly increased.

Mills Creek.—Mills Creek has yielded more gold than any other stream of the Turnagain Arm field except Canyon Creek, and is probably better known than any other stream. It is nearly 5 miles long, but the important known gold-bearing gravels extend only from the mouth of the creek to the mouth of Juneau Creek, a distance of three-fourths of a mile. The stream here flows along the contact of the gravels and hard rocks, producing a canyon whose south wall is chiefly rock and whose north wall is chiefly gravel (Pl. X, *A*). The channel is cut principally in gravels, for the waters have not yet greatly attacked the underlying slates and arkoses.

The upper portion of Mills Creek lies in a round-bottomed valley, covered with *gravels and bare of timber*. High gravel benches are seen near the mouth of Juneau

A. GRAVEL BENCH NEAR THE MOUTH OF MILLS CREEK.

Looking across Canyon Creek. The valley of Mills Creek is seen on the right.

B. MILLS CREEK JUST BELOW THE MOUTH OF JUNEAU CREEK.

Juneau Creek once flowed through the gravel-filled channel over which the pipe line lies. Shows the manner in which bowlders are handled.

Creek and, as stated, form the north wall of the canyon below that point. Minor gravel benches are present in the upper valley. These high gravels have been described in the account of Canyon Creek, of whose benches they are a part. The stream gravels, as far as the writer could discover, were derived from the neighboring country rock, from which they differ in no way. They comprise slates and arkoses with occasional bowlders of conglomerate, consisting of rolled quartz pebbles in a fine-grained slaty cement. Such conglomerates were seen in place near the mouth of Canyon Creek.

The gravels of the canyon are unstratified or only rudely stratified. At the mouth of Juneau Creek (Pl. X, *B*) the work of the last two seasons has shown an old channel filled with gravels, the lower portion strongly cemented with iron oxide, resting on a tough, ill-smelling blue clay—the "bed rock." Part of the gold is scattered through the brownish cement gravel, but the best pay lies on the top of the blue clay. All the gold is heavy and flattened, but that from the cement gravel is the finer, averaging perhaps one-eighth inch in greatest diameter. Some of the larger nuggets found on bed rock are distinctly striated, as if rubbed against or dragged over a rough surface.

All of the mining in the canyon has been carried on with pick and shovel, and in this way all that portion of the gravels has been exploited. At present two hydraulic plants are in operation, one at the mouth of Juneau Creek, the other at the mouth of Mills Creek. The latter might better be regarded as being on Canyon Creek, although the ground is part of that belonging to the old Polly Mining Company. Water is obtained from Juneau Creek and is delivered at the mouth of that stream with a head of 280 feet. It was here found that this head was sufficient to tear out the cement gravel, but that it did not break it up enough to release all the gold, and that even small nuggets were carried through the boxes. The sluice boxes, usually having a grade of 5 to 6 inches to the box length (12 feet), are built with false sides and the riffles are covered with strap iron to protect them from wear. No mercury is used in the boxes. The tailings are dumped into the stream below; the bowlders are wheeled out and piled along the channel. A liberal use of powder to break large bowlders has proved economical.

The scarcity of white laborers in the spring resulted in the employment of natives during the season of 1904. They receive smaller wages than white men and when tactfully handled earn their pay, but in most cases can not be depended on to the same extent. It was said that the canyon of Mills Creek has been once worked over, yet there still remain small areas, at least, sufficiently rich to pay for sluicing. The banks have never been worked at all; no doubt they will receive some attention in the future.

East Fork.—East Fork is the larger of the two branches of Sixmile Creek. It has been worked only in the lower mile of its course, between the forks and the mouth of Gulch Creek. The production is about $16,000 to $17,000. This part of the stream lies in a shallow rock-walled canyon, cut through grits and arkoses, overlain by gravels. These gravels continue through the upper valley and appear as well-formed terraces in many places. None of these have been prospected.

The stream carries a larger body of water than Canyon Creek and the difficulties in handling gravels are the same as there. Wing dams are always necessary and china pumps run by the current are used to keep the pit dry. At the time of the writer's visit no mining was being done on East Fork.

Gulch Creek.—Gulch Creek is a small stream joining East Fork 1 mile above the mouth of Canyon Creek. Like the majority of the streams in this region its lower course is through a narrow canyon. The gravel benches, such as are seen in the larger valleys, are also present but are not so prominent. The creek gravels are made up of material like the bed rock, slates, and arkoses, and contain many large bowlders and angular blocks, usually arkose rather than slate. The gold production

is about $25,000, nearly all of which was taken from the lower part of the creek by pick and shovel work. A hydraulic plant located three-quarters of a mile above the mouth of the stream proved unprofitable, and was in operation during the season of 1904 only long enough to complete the assessment work.

Lynx Creek.—Lynx Creek joins East Fork 7 miles above Canyon Creek, directly opposite the mouth of Granite Creek. It is about 3 miles long and occupies a narrow valley between high, rugged mountains. Deep gravel deposits are found at the mouth of Lynx Creek and continue well into the valley. Beside the usual slates and arkoses two or three large, rounded bowlders of altered diabase were seen in the gravels on one of the claims. These may have come from the neighboring hills, but no such rocks were seen in place by the writer. Two claims have furnished most of the gold taken from this creek to the present time (1904). These have been practically worked out and little in the way of placer mining is now done on the creek. The gold is heavy and contains numerous pieces of native copper whose probable source is the ledge now being opened up at the head of the creek. All work on Lynx Creek has been done with pick and shovel. Owing to the low grade of the lower part of the stream the gravels there have not been exploited. To overcome this difficulty a tunnel about 500 feet long and below the level of the water at its head is being driven to divert the stream. It is the intention to place sluice boxes in the tunnel and wash all the gravel through to the valley of Bench Creek. The production of Lynx Creek to the year 1904 was about $87,000.

Silvertip Creek.—Silvertip Creek has not been an important gold producer and presents no features of special interest. The entire output probably does not exceed $4,000. A hydraulic plant installed about a mile above the point where it joins East Fork did not prove successful, and the work was abandoned.

Granite Creek.—Granite Creek, one of the largest tributaries of East Fork, heads against Quartz Creek and thereby furnishes easy communication with the upper part of Turnagain Arm. Some work, more in the nature of prospecting than of mining, has been done on this stream or its tributaries for a number of years. The valley of Granite Creek below Bertha Creek is from one-quarter to one-third of a mile wide, and in many places is wet and marshy. Gravel terraces are seen here and there and the whole region presents the appearance of having been occupied by a lake or series of lakes, possibly at no distant time. A hydraulic plant, in operation for the last two years at the mouth of Bertha Creek, has been fairly successful. Here there are from 8 to 10 feet of coarse gravel and bowlders covered by 4 to 5 feet of finer wash. The gold is mostly taken from the coarse gravel, but the whole mass averages about $0.15 to the yard. Bed rock has not yet been reached. The gold is fine, bright yellow, and fairly smooth, the largest pieces being worth about 25 cents. Bertha Creek can be depended on for 400 inches of water, and if future developments warrant the expense, a flume can be constructed to bring water from the upper part of Granite Creek.

A rock carrier, driven by water power, for handling the bowlders, and a small homemade sawmill have been built. This mill is simply an ordinary whipsaw set in a square upright frame and driven by a water wheel with suitable gear; it will saw three times as much in a day as two men can saw by hand and is well worth the slight cost of construction.

GLACIER CREEK VALLEY.

Glacier Creek has never been a gold producer and is therefore important at the present time only because of its tributaries. It takes its name from several small glaciers at its head and flows on the broad, gravel-covered floor of a glaciated valley. Crow Creek, California Creek, and Winner Creek have yielded some gold. The production of Glacier Creek Valley—that is, of the three branches named—including the season of 1904, is over $51,000.

A. CROW CREEK JUST ABOVE THE CANYON.

Shows stone boat and wheel, run by the "giant," used in removing bowlders.

B. CANYON AND FALLS NEAR THE LOWER END OF CROW CREEK.

Such features characterize the lower portion of most streams on Kenai Peninsula.

Crow Creek.—Crow Creek is the largest tributary of Glacier Creek, and might properly be considered the head of that stream. It rises in the high mountains of the divide between this part of the Turnagain Arm drainage and Eagle, or Yukla, Creek, a tributary of Knik Arm. The lower half mile of the stream flows through a narrow rock canyon not over 5 feet wide at one point. (Pl. XI, *B.*) Above is a broader gravel-walled canyon or narrow valley extending northwestward to the mouth of Crow Gulch, where it broadens out suddenly to a basin three-quarters of a mile long, then, swinging abruptly northward, contracts to a narrow V-shaped valley and continues thus to the divide.

The bed rock comprises interbedded slates, arkoses, conglomerates, and banded quartzites, striking about N. 45° E., and cut by occasional dikes of light-colored granite.

The gravels are of three kinds, high-bench gravels, glacier deposits, and stream deposits. The first continue into the valley from Glacier Creek, and where most prominent have an elevation of nearly 1,000 feet. The top of the gravel bank east of Crow Creek at the head of the rock canyon is about 100 feet above the stream. On the west side a deep cut in the bank showed a perpendicular face 50 feet high in rounded gravels of fairly uniform size—that is, without large bowlders and with no marks of bedding. These high gravels were laid down in an old valley, whose stream was thereby forced to seek a new outlet and is now cutting the narrow canyon through the rock barrier which it encountered at its lower end. Near the middle of the rock canyon the work of the latter part of the season of 1904 disclosed the beginning of a well-developed, gravel-filled channel east of the present channel. This showed well-shingled stream gravels, and was expected to lead into the basin above the canyon. At the end of the season it had been followed in about 40 feet. The stream gravels show a large amount of material more recent than the bench gravels, consisting of angular blocks of arkose and slate, with many bowlders of light-colored granite, part of which are thought to be the product of erosion since the bench gravels were laid down. They are interbedded with finer clayey gravels and sands. A short distance above the rock canyon, mining has shown that here the base of the gravels must be considerably lower than at the head of the canyon; in other words, owing to the filling of the old outlet the deposits here appear to occupy a basin (fig. 4). The section includes loose sand resting on bed rock, overlain by blue clay, yellow clay, gray gravels, and surface wash. A few very large bowlders are present.

Another gravel-filled basin is seen farther up the stream. About one-quarter of a mile above Crow Gulch a long, curved "rock reef" extends across the valley and forms a well-marked ridge, with convex side downstream (fig. 4). A 60-foot cut had to be made through this "reef" in order to sluice the ground above, and it was found to be made up of immense bowlders and angular blocks, sometimes 10 to 12 feet in diameter, thrown down in greatest confusion. Plainly it is a terminal moraine left here by the retreating glacier, which still appears in contracted form in the high valleys to the north. Behind this barrier the gravels were confined and laid down with more or less regularity. The beds may be seen abutting against the upper side of the moraine, which cuts them off from the stratified gravels below. The section disclosed in piping the ground includes fine sandy beds, separated by beds of angular wash and coarse bowlders. These beds average from 2 to 3 feet in thickness. An interesting event, occurring at the time of the writer's visit to Crow Creek, may throw some light on the way in which these sandy and angular wash beds were formed. A very heavy rain brought down a large quantity of débris from points farther up the valley and filled the channel above the rock canyon—here from 75 to 100 feet wide—to a depth greater than the height of the sluice boxes, or over 2 feet. This material, as far as the writer could determine, was like that of the coarse, angular wash seen above. If this were followed by a period in which finer sands or clays

were deposited and the whole process repeated, a similar series of beds would be formed.

Some gold has been panned from the bench gravels, but never in sufficient amount to encourage further work. The creek gravels are therefore the source of supply. Rich spots were found in the lower part of the rock canyon, and the old channel discovered last season yielded gold at the rate of 6.5 ounces per yard of gravel moved. Above the canyon the pay is irregular, and is taken chiefly from the yellow clay and the gray gravels. The former carries coarse gold; that from the latter is finer. Both

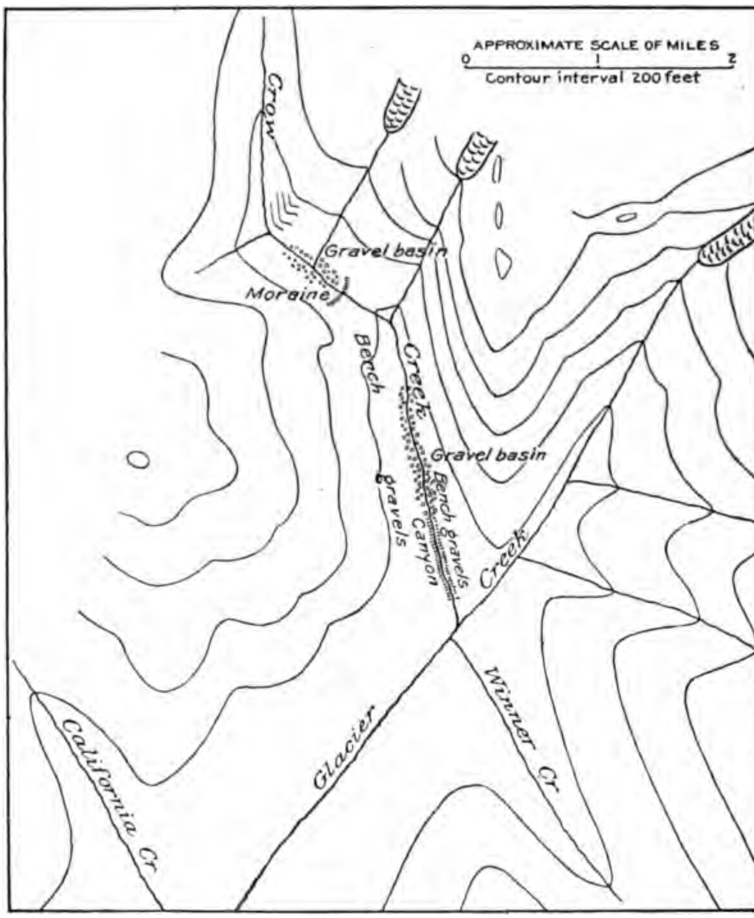


FIG. 4.—Sketch map of Crow Creek, showing terminal moraine and gravel basins.

these beds are tough and hard to pick, but the yellow gravel is the richer. In the upper part of the stream the pay is obtained almost entirely from the coarse wash, although the sandy beds carry some fine gold.

Crow Creek gold is of two distinct grades—one coarse and pale yellow in color, the other fine and bright yellow. It assays $14.80, and with it are associated native silver, copper, and a little black sand. The largest nugget found was valued at $25.97. The conditions under which these gravels were probably laid down makes it appear that some places are decidedly more favorable for the deposition of gold *than others and that* consequently future developments will show the stream to be

"spotted." It should be said, however, that careful prospecting in the upper basin and the results of last season's work in the lower basin above the canyon give an average of 46 and 44 cents in gold per yard of dirt moved. Most of the gold produced on Crow Creek has been taken with pick and shovel, but at present the whole of the creek is under two separate managements, both of which make use of hydraulic methods and have better equipment for such work than is found on the other streams in the field. The creek carries from 3,000 to 6,000 inches of water, according to the season, and above the canyon has a grade of 2.5 per cent. The extraordinary size and quantity of bowlders is the chief difficulty to contend with in mining, necessitating the use of considerable powder in reducing the blocks to a size which can be handled by the derrick. (Pl. XI, *A*.)

On the lower group of claims water is brought from the mouth of Crow Gulch by a ditch 460 rods long, and is delivered at the upper end of the canyon with a head of over 200 feet. A double tailrace is used, in which the water may be changed from one side to the other when repairs are necessary or when any other condition makes the change desirable. Tailings are dumped into the canyon.

On the upper group of claims nearly the whole of the season of 1904 was spent in making the cut through the moraine, or "reef," as it is called. Twenty men were employed during the early part of the season, but this number was cut down when it became too dark to run a night shift. A head of 250 feet of water is used. The gravels are sent through an 8-foot race having a grade of 4.5 inches to the rod. It is said that 1,500 to 2,000 yards a day can be handled. The tailings are dumped into the stream below, but after seeing how gravels are carried down by higher water one is led to think that this practice may seriously interfere with work on the lower claims unless some measures are taken to impound at least the coarse material. This ground has been well prospected by holes and a few crosscuts, so that the management feels justified in incurring the great expense which was necessary to open the ground. The working season is several weeks shorter here than at the lower end of the stream, since the claims are above timber line and are entirely unprotected from the cold winds of the valley.

California Creek.—This stream has cut a steep, narrow, V-shaped valley in the mountains west of Glacier Creek, which it joins 2 miles from the arm. Its bed rock comprises the same materials found on Crow Creek. The gravels are similar, also, but carry less granite and do not show in the same degree the effect of glacial action. A few thousand dollars were taken out in 1896 and 1897, but of late years nothing more than assessment work has been done. It was proposed to set up a hydraulic plant and build a sawmill last season, but for some reason the project was not carried out. There is some good spruce timber near the mouth of the stream, which may be of considerable value in the future.

Winner Creek.—Winner Creek joins Glacier Creek just below the mouth of Crow Creek. Its valley, bed rock, and gravels resemble those of California Creek. Like the latter, it was worked slightly in the early days of the field, several thousand dollars in gold being taken out in 1898 and 1899, but in the following year it produced little or nothing, and in 1904 no mining was carried on.

MISCELLANEOUS LOCALITIES.

Small tributaries of Turnagain Arm.—Gold is present in the gravels of nearly all, if not all, the other streams flowing into Turnagain Arm, but no one of those not already described has been an important gold producer. Not a little work has been done on Seattle and Quartz creeks, also on Sawmill Creek, and gold has been obtained, but in small quantity.

Kenai River Valley.—The immense deposits of gravel along Kenai River afford ground eminently suited to hydraulic mining and have been prospected at several points, in the hope of finding gravels of sufficient value to pay for working in that

manner. Some of the tributaries have also been prospected. In the upper valley of Kenai River, False Creek, a small tributary of Trail Creek, was receiving some attention in the early part of the season of 1904. It flows in a steep, narrow valley, whose angular gravels are derived from the neighboring hills. At the time of the writer's visit several days' shoveling had yielded sufficient gold for a grubstake to enable the men to continue work.

An unsuccessful hydraulic plant was located on the north shore of Kenai River near the lower end of Lake Kenai in 1898, but was abandoned later. Some prospecting is now carried on in the upper valley of Juneau Creek, a tributary to Kenai River, not to be confounded with the stream of the same name tributary to Mills Creek. A second hydraulic plant is located on the high gravels south of Kenai River about 2 miles above Lake Skilak. It was not in operation last season. The writer learned, however, that the small quantity of gold procured during the previous year all came from a few inches of the top gravels.

The only gravels in the Kenai River Valley which have paid for working are found on Cooper Creek and a small branch—Stetson Creek.

Cooper Creek joins the river 2 miles below Kenai Lake. It rises in a small lake and is said to head against the upper part of Resurrection River, flowing into Resurrection Bay. Near the mouth it has cut through deep stratified gravels, showing a bank on the east side of the stream between 100 and 200 feet high. The stream gravels, however, are the present source of the gold. Most of the pay from the creek was taken from a single claim in a single year. It is said that a profit of 14 pounds in gold was made that year, which would indicate a total production of possibly $5,000 or $6,000. The product of the other claims and of Stetson Creek is small.

Tustumena Lake.—Prospecting on the small streams emptying into the eastern end of Tustumena Lake has shown the presence of gravels carrying gold in small amount. Some attempts have been made to exploit them, and for a number of years there has been a little mining on Indian Creek. A hydraulic plant was taken in by way of Kasilof River, and has been in operation, but the results of the work were not learned. It is known, however, that work will be continued. Access to the lake by way of the river is not difficult if one understands how to take advantage of the tides, and this is the route usually followed.

Anchor Point.—The beach sands at Anchor Point yield a few ounces of gold each year to prospectors looking for a "grubstake." This is all fine gold, and although locally said to be washed up by the waves of Cook Inlet, is probably derived by concentration from the gravels of the cliffs along the shore which are here rapidly undermined by the water. A hydraulic plant was formerly located at Anchor Point and much money was spent in the construction of ditches and buildings, but the whole undertaking proved a failure, except in that it has since furnished pipe and other material for several hydraulic plants on Turnagain Arm.

SOURCE OF THE PLACER DEPOSITS.

Placer gold is derived from an original supply contained in various ways in bed rock and is ordinarily found at a locality more or less distant from the place where it was freed from the rock. A discussion of the source of placer gold does not, however, necessarily involve a consideration of either the manner or form in which it was deposited in its previous condition, so that in this paper the occurrence of gold in bed rock is treated principally in its relation to the occurrence of gold in the gravels.

Among the miners of Turnagain Arm there are two opinions concerning the origin of the placer gold—first, that it is derived from a local source; second, that it has been brought from a distance by the transporting power of glacial ice. There can be

no doubt that a large part of the gold is of local origin. It is more difficult, however, to show what portion, if any, has been derived from any distant source.

In two localities in the Turnagain Arm field gold-bearing quartz veins of sufficient importance to attract the attention of miners are present, and steps have been taken to determine their possible commercial value. Small mineralized quartz veins are also exposed along the rocky shores of the arm, and fragments of quartz veins showing chalcopyrite with peacock stain are not uncommon in the surface gravels in the upper valley of Crow Creek. On a steep talus slope south of Bench Creek and high above the stream the writer picked up pieces of arkose or fine conglomerate, on whose surface were flakes of free gold. At the time it was thought that the gold was contained in the rock, but more probably its presence there was due to the rubbing of the rough surface of the bowlder against fragments of the metal, either loose or still attached to their original matrix. It is stated that free gold has been found in the sluice boxes imbedded in small fragments of slate and with no attached quartz.

It appears that in this region the openings in the rocks resulting from the readjustment due to the various movements which effected them have been completely or partly filled by depositions of quartz. As far as the writer has observed the quartz occurs in the form of small veins or lenses which may branch or intersect, producing in places a kind of network. Occasionally the quartz deposits reach thicknesses of 3 to 4 feet, but none of those observed could be shown to be continuous for more than short distances; in other words, their horizontal extension on the surface was limited and they have the appearance of irregular lenticular bodies rather than continuous veins. Both the larger and the smaller veins may contain sulphide minerals, usually pyrite with arsenopyrite or chalcopyrite, or both, sometimes zinc blende and galena. Further, some of the veins are known to carry gold, at times visible to the eye, but more frequently revealed only by assays.

It has been seen that the gravel deposits, which have been exploited with profit, were found in stream channels and that much of the gold was obtained from the coarse, angular wash, especially where clay was present. Mining in the high gravels has not been carried on with even a small degree of success in more than one instance, although fine colors are frequently found scattered through them. Coarse gold, though it may be present, has not been found in the high gravels even when bed rock has been reached, as is the case on Canyon Creek, where, in the course of two years' mining on the bench east of the stream, the largest piece of gold obtained had a value of only 25 cents.

The writer would suggest, then, that the present stream-gold deposits are formed in two ways—first, by the breaking down and decomposition of mineralized veins in the country rock; second, by the concentration of the gold contained in the bench gravels. The gold in the bench gravels is itself a secondary deposit and may have been derived from two possible sources; like a part of the gold in the stream gravels, it may have had its origin in local deposits in the country rock, or it may have been transported to its present location from some place outside the present drainage basin. Evidence has already been given to show that the deep gravels of Sixmile and Resurrection creeks, and especially those of the country west of the Kenai Mountains, are not entirely local in origin but contain fragments of rocks that are not represented, or at least not found, in the Kenai Mountains—fragments that were probably brought by glacial transportation or by floating ice from the mainland on the north. It seems fair to suppose then that the ice which transported this material may have carried with it some gold, but even if this is true, the facts presented indicate that the gold in the deep gravels and to a still greater degree that in the stream gravels is of local origin.

Of far greater importance is the influence of glacial action on the deposition of gold. A most noticeable feature of the side streams of the region is the almost constant occurrence of broad, round-bottomed upper valleys, which give place to steep, narrow

canyons below. These valleys were once occupied by ice, whose downward movement carried along both the débris falling on its upper surface and that lying on its bed. On some creeks this débris was moved only partly down the valley; on others it was carried entirely out of it. Frequently both operations must have taken place in the same valley, since a glacier that originally occupied all of a valley threw down, in its retreat, the transported material at successively higher and higher points. The effect of erosion would be to sweep the débris down the valley and localize it. Further, the grinding of the material within and beneath the ice would tend to free the gold which, at the same time, would be subjected to the concentrating power of waters derived from the melting glacier itself. The production of small local basins of quieter water, due to barriers formed by terminal moraines, permitted the finer particles of gold to come to rest. The former presence of such basins is most plainly seen in the gravel deposits of Crow Creek. It must be remembered that the glaciers whose workings have just been considered are local. Their sources are within the valleys where they occur, and while their general effect is to transport material from higher to lower levels, they do not ordinarily cross the high ridges between valleys. If the large number of granite bowlders seen on the shores of the lower Kenai Lake and along Kenai River and the great granite blocks of the coast at Kenai were brought to this region by glacial transportation from some locality farther north, the glacier must have been of far greater extent than those which recently occupied the valleys of the Kenai Mountains. Such a glacier might readily carry some gold in its load of rock waste.

Regarding the character of the gold itself, it may be said that the bright-yellow color of some and the pale yellow of other gold does not necessarily imply that the two were brought in at different times, although the fact that they are confined to a certain extent to different beds of gravel on Crow Creek would indicate that such is the case there. Such characters may result from differences arising at the time of the original depositions in the country rock, possibly indicating different solutions and different periods of deposition.

Whether the bench gravels contain gold deposits sufficiently concentrated to be profitably treated is an important problem, since on its solution depends, in a large degree, the future of this placer field. If the suggestions concerning the origin of the gold are true it seems not unlikely, when it is remembered that these gravels were laid down in an old valley produced by the erosion of a far greater amount of material than has been removed since their deposition, that there may be found old channels as rich or richer than any yet found. Indeed, one such appears already to have been discovered on Crow Creek.

AURIFERCUS LODES.

Since it is reasonable to suppose that placer gold is derived in most cases from the region drained by the stream in whose valley the gold-bearing gravels are found, there has been more or less effort on the part of the miners of Kenai Peninsula to find the source of the gold. At two localities in the Turnagain Arm region mineralized veins have been found, on Bear and Sawmill creeks. Besides these, other localities will be mentioned which were not visited by the writer.

BEAR CREEK VEINS.

The known gold-bearing veins on Bear Creek occur in the midst of the broad amphitheater at the upper end of the valley. Small quartz stringers were first found in the arkoses of the stream bed and on further investigation led to the initial steps in the development now in progress. At the locality where work began the arkoses are somewhat brecciated or closely jointed, and the openings formed were filled with quartz, appearing as veins from one-half to three-quarters inch thick. Samples of

QUARTZ LODE ON SAWMILL CREEK.

Shows the tunnel and the arrastre for treating gold ores.

the larger veins show sphalerite, galena, pyrite, and arsenopyrite, the peacock stain of copper, and a little free gold. The gangue is chiefly quartz, but contains some calcite. As the shaft was filled with water and the débris produced in enlarging the original opening, the writer did not see the veins from which these samples were taken, but was informed that the best ore was a 16-inch vein in a zone of mineralized rock 6 feet thick. No underground work other than the enlargement of the shaft had been undertaken at the end of July, 1904. This shaft has a cross section of 10 by 5 feet and a depth of 30 feet. There is a short drift at the bottom. The surface equipment consisted of a new head frame and a 4-ton boiler for operating the hoist and air compressor. A good road leads down the valley from the claims to Hope.

SAWMILL CREEK VEINS.

Gold-bearing veins were discovered on Sawmill Creek very early in the development of the region and occur at three localities, which, however, are probably not entirely unrelated to one another. These are on the shore of the arm a short distance east of Slide Creek, on Slide Creek about one-half mile from the beach, and on Sawmill Creek one mile from the beach. The three lie nearly on a straight line, corresponding in direction with that of a number of fault planes observed here. At the first locality a small quartz vein in slates lies along a fault plane, striking N. 70° E. and dipping 70° E. The rock surface of the hanging wall is smooth and highly polished. Samples of the quartz assayed $2 in gold per ton. On Slide Creek quartz veins occur along two fault planes, the first similar to that just described, the other striking N. 50° E. The strike of the bedding is N. 10°–15° E. Quartz from this locality carries a higher percentage of gold.

On Sawmill Creek the gold-bearing quartz is found along a fault zone running northeast and southwest. It is difficult to make out the structure of the slates and arkoses which are here greatly disturbed, for the fault is not a simple one, but apparently is made up of minor displacements, with no parallelism, which took place at different times. The walls are frequently striated and between them a thin gouge is usually present. An adit 60 to 70 feet long was started on a branching quartz vein having a maximum thickness of 4 feet but of very irregular dimensions. It appears to have been cut off by movements occurring after its formation, since the vein was lost and the extension of the adit did not rediscover it. The continuation, however, may possibly be found to be the quartz vein located a short distance north of the adit. This second vein is about 3 feet thick and is less disturbed than the other. It carries low gold values but no attempt has been made to extract them.

The first vein carries free gold in a quartz gangue containing arsenopyrite, pyrite, zinc blende, and galena. Crystals of arsenopyrite are also very abundant in the country rock. A small streak of rich ore, said to carry $90 per ton, pitched steeply northeastward under the creek and could not be followed because the water broke in and stopped the work. In order to save the expense of shipping ore a small arrastre (Pl. XII), driven by water power and capable of handling two 700-pound charges a day, was erected near the adit, and with it the ore is treated. Nineteen tons of picked ore put through this arrastre yielded $500, or a little more than $26 per ton.

MISCELLANEOUS VEINS.

During the early part of the season the writer was shown samples of quartz containing pyrite and said to carry gold. They were taken from a newly discovered vein about a mile southwest of Seward. The ground was staked and a little work was reported to have been done at the end of the season. A second locality is at Aurora, on the south shore of the upper end of Kachemak Bay. The rocks of the Kenai Mountains are here cut by dikes of porphyry and contain quartz veins. Some portions of the country rock are highly pyritiferous and carry a small amount

of gold. Extensive preparations for mining pyritiferous deposits were made but finally discontinued and nothing beside assessment work has been done for the last two years. A wharf was constructed and one or two tunnels were started on the claims. A stamp mill also was landed, but was never set up, and is still stored at the beach.

COPPER.

Small pieces of native copper are found with the placer gold on several of the streams previously described. This copper was most abundant in the sluice boxes on Lynx Creek and led finally to the discovery of a ledge carrying copper sulphides, located on the mountain side at the upper end of the valley and well above the stream. Although the presence of the outcrop has been known for some time no steps toward determining its commercial value were taken till some time during 1904, when a company was raised for its exploitation. Much of the season was spent in preparation for opening the deposit and the field operations of the company did not begin until some time in August, so that comparatively little rock work had been done when the Survey party left the peninsula. An adit level, driven to strike the lode below the outcrop, had not cut it in the early part of October, but it was reported that work would be continued during the winter. At present supplies are brought to the camp from Sunrise by pack train, but if this prospect should develop into a paying mine connection with the Alaska Central Railroad could be established without serious difficulty.

ECONOMIC CONDITIONS.

ROUTES AND TRAILS.

Many of the first prospectors in the Turnagain field came into the region from Prince William Sound by way of Portage Glacier, for at that time there were no steamers making regular trips to Cook Inlet and, moreover, it was unsafe for boats to enter during a large part of the year because of ice. Winter mails continued to be brought in and sent out in this way for a number of years in the earlier history of the field until the overland mail routes from Seward were established. The passage over the glacier, though not very difficult at the proper season, is often dangerous because of the fierce storms which sweep through the gap and have caused suffering and death in a number of cases. At present this route is not frequently used.

During the open season on Cook Inlet—that is, from the end of March to the beginning of November—the most convenient and customary means of reaching Hope or Sunrise is by the small steamer which connects with the ocean-going boats at Seldovia and carries mail, freight, and passengers to the upper end of the inlet. During the early days large boats occasionally went up the inlet in the summer months, touching at Tyonok, where it was necessary to transfer to small boats, often dories, in order to reach Turnagain Arm. At present these large vessels do not go farther north than Seldovia or Homer. The harbor at the former place is well protected, but small, while the anchorage behind Homer Spit, farther up Kachemak Bay, is swept by strong winds at certain seasons.

Large boats can not enter Turnagain Arm, but small ones of light draft reach Hope or Sunrise at high water and usually lie over until the next high tide to leave. At low water they are stranded on the mud flats. The completion of the Alaska Central Railroad will probably change the freight and passenger route into this region. Seward, the coastal terminus, possesses a splendid harbor, whose chief fault is its great depth. It is open all the year round and is well protected on every side. The railroad company has constructed a good wharf, at which steamers unload directly, without lightering, and had completed about 12 miles of track when work was shut down for the winter. Although the route chosen does not pass the camps on Sixmile

Creek, it crosses the upper end of the arm, from which connection with Sunrise can be readily established.

The trail from Seward to Sunrise along the east end of Lake Kenai and the Trail Lakes to Johnson and Bench creeks, and thence down East Fork of Sixmile, was the one followed by the Survey party in the trip across the peninsula. A very good trail leads from the forks of Sixmile to Mills Creek also, and thence to the lower end of Kenai Lake. This trail connects with the Trail Lakes trail by way of Moose Pass. Resurrection Creek may be reached from Sunrise by trail along the shore of Turnagain Arm from Mills Creek by way of Pass or Summit creeks. A good road has been constructed from Hope to the hydraulic plant 3 miles above Sixmile Point on Resurrection Creek, whence a trail leads to Pass and Fox creeks. There are also good roads up Bear Creek and from Hope to Palmer Creek. The camps on Crow Creek may be reached from the shore of the arm by a road lately completed, a large part of which is corduroy.

There is no trail for horses down Kenai River from the upper to the lower lake except the temporary one, most of which was cleared out by the Survey party. It followed the dryest ground and undoubtedly could be straightened somewhat. The horses of the Survey party were taken over the ridge north of Lake Skilak without packs, consequently little cutting was necessary, and there is practically no trail there at all. Moose River may be reached from the lower end of Lake Skilak without difficulty, but the writer would strongly advise against taking loaded horses from that point to Kenai. It was done by the Survey party late in the summer, when conditions were most favorable, but there is danger of losing the horses. Possibly by following the river bank a better though much longer trail could be found.

CLIMATE.

Climatic conditions on Kenai Peninsula are not the same over the whole area. The south slope of Kenai Mountains and the lower part of Cook Inlet are influenced more directly by the currents and winds of the Pacific, and the climate there is similar to that of southeastern Alaska. There is much rainy or foggy weather and extreme temperatures are not known. During the winter of 1903–4 a temperature of −2° F. was reached only once at Seward, and the same was true at Seldovia.

The climate of that part of the peninsula that lies north and northwest of the divide is much like that of the interior, except that it is more changeable. The winter temperatures are much lower in this region than along the coast, the difference sometimes being as great as 30°, while in summer the temperatures are higher. Other weather conditions are more local. Clouds and rain may prevail for days on Turnagain Arm while the sun shines brightly on Cook Inlet; or these conditions may be reversed. On Turnagain Arm, in summer at least, the wind is either from the east or from the west, for the deep, straight valley of the arm seems to have a local controlling influence on its direction, regardless of whatever way it may blow outside. Fair weather usually accompanies the west winds, while east winds bring clouds and rain. Different temperatures prevail in different valleys. It is said that the temperatures on East Fork are lower than on Canyon Creek, and that in the coldest weather it is 10° warmer at Sunrise than at the Forks. On Sixmile Creek the snow lies 2 or 3 feet in the valleys, but is not so deep along Kenai River and on the west side of the peninsula.

Work is begun on the creeks about the first or middle of May and is continued till the first or middle of October. In 1904 gravels were washed on Crow Creek until November 15—an exceptionally long season.

Most of the claims of the Turnagain Arm field are well situated for hydraulic mining as far as water pressure is concerned, and water is obtained without great expense. The water supply is largely dependent on melting snows, consequently when the snow goes quickly in the spring a short flood period may occur, followed on small streams

by scarcity of water, which continues till the July rains. The summer of 1904 was both cool and wet. Snow on mountains usually bare in July and August did not melt, and water was plentiful the whole season.

Some statistics may be of interest. During the time the survey party was in the field Mr. Hamilton kept a record of temperature observations taken twice each day, in the morning and evening. The averages of these observations were: June, 48.4° F.; July, 44.2°; August, 48.9°; September, 41.8°; first 18 days in October, 40.2°. Rain fell on 79 of the 140 days, nearly twice the number in the same period of the previous year, as determined from records kept by Mr. R. E. Oldham, on Crow Creek. The coldest day of 1904 on Crow Creek was −13°.

Records of temperatures and precipitation kept at Kenai show that during a period covering about eight years from 1882 to 1886, and from 1899 to 1902, the average yearly precipitation was 16.55 inches. Four times during that period the precipitation was as great as 1 inch in 24 hours, the greatest fall in 24 hours being 1.77 inches. The months of July, August, and September show the largest number of rainy days and the greatest precipitation. From 1899 to 1902 the highest recorded temperature was 80° and the lowest −43°.

TIMBER AND VEGETATION.

The Kenai Peninsula possesses a heavy growth of timber, which covers the whole area up to an altitude of 1,500 to 2,000 feet above sea level. This timber is chiefly spruce, but with it is found some hemlock, especially around Turnagain Arm. Cottonwood and willow grow along the streams; small poplars are abundant on the higher ground of the country west of the Kenai Mountains; birch and alders cover the mountain sides, the latter reaching well above the limit of spruce timber and making climbing very difficult. Near the coast the spruces are often hung with moss, while beneath the "devil's club" awaits the unwary. Lumber suitable for many purposes could be obtained at a reasonable cost near most of the camps. Till within the last year or two much of the lumber for sluice boxes was whipsawed by hand, but there is now a mill at Hope and another at Seward; the latter, however, has not yet supplied any lumber to the Turnagain Arm field. Better grades of lumber, especially that used for boats and other purposes where woods less brittle than spruce are required, are brought from Seattle, at a cost of from $35 to $50 per thousand. Many acres of valley lands have been burned over and are now strewn with the tangled trunks of fallen trees. These make traveling very difficult, and even dangerous at times, for on windy days the crash of falling trees is heard continually. In some areas the burning of this timber was accidental, or was the result of carelessness with camp fires; in others it was done purposely to kill the moss and destroy the breeding places of mosquitoes and flies. Without doubt these pests are less numerous in such areas than they were formerly. Other areas in the flats between the Kenai Mountains and Cook Inlet were burned over many years ago, and are now covered with a growth of young poplars and birch.

Good feed for horses is found in all the valleys visited by the survey party. Grass grows to an unusual height and is especially abundant about timber line, in the upper timberless parts of the valleys, and in places where the timber has been burned for a number of years. There is fine grass in the hills north of Homer, where horses and cattle have wintered without other feed. It is quite possible that with a suitable market these highlands could be utilized for cattle raising. The Department of Agriculture maintains an experiment station at Kenai with a view of determining the agricultural possibilities of this region.

Currants, cranberries, blueberries, huckleberries, and a few salmon berries are found at the proper seasons. Vegetables are grown successfully. Many miners have their own gardens, where potatoes, cabbage, turnips, rutabagas, and radishes were seen growing.

NATIVES.

The native inhabitants of the upper Cook Inlet shores, the Kenaitze, as they are called, are the only interior Indians (Athabascan) that reach the coast. The natives living about the southern part of Cook Inlet and along the Pacific coast to the east and west are related to the Eskimos. Besides these purely native inhabitants there is a people of mixed blood, the Russian creoles. The largest native settlements are at Kenai and Seldovia, where they have churches and schools. Smaller settlements or single families are found at Hope, Kasilof, Alexandrovsk, and a number of other places. Probably the entire native population, including those of mixed blood, is between 200 and 300, possibly over 300. Descriptions of these people have been given by Dall, Petrof, and others and need not be repeated. They are under the influence of the Russian Church, speak the Russian language, or a corruption of it, as well as their own, and have adopted many of the white man's habits, living partly by hunting, trapping, or fishing, and partly by working for the whites. They are employed by the canneries at Kenai and Kasilof and in one instance at the placer mines on Mills Creek. Under the direction of white men a considerable part of the lightering at Seldovia and Kenai is done by them, and for this work they are paid 10 cents an hour. A few make part of their living by supplying moose meat to the miners of Turnagain Arm. Their numbers are gradually decreasing, and several villages once occupied by them have been abandoned.

GAME AND FISH.

From the time of the first visit by Captain Cook to the discovery of gold on Resurrection Creek furs and fish were the only inducements bringing white men into the Cook Inlet region. The fur trade, after the purchase of Alaska by the United States, was largely in the hands of one company, whose trading posts were located at various points on the inlet and furnished the natives with such things as they desired in exchange for the furs they had taken. This trade was carried on with natives from Sushitna, Matanuska, and even upper Copper rivers, as well as the east and west coasts of Cook Inlet. The list of fur-bearing animals on Kenai Peninsula and Cook Inlet waters is a long one, in which the most valuable are black fox, sea otter, and silver-gray fox. Beside these, approximately in the order of their values, are martin, cross fox, black bear, brown bear, lynx, land otter, wolverene, black or brindle wolf, red fox, silver-gray wolf, and mink. "Ermine," muskrat, marmot, and parka squirrel also have an occasional market.

Brown and black bear are numerous in the Kenai Mountains, and after the salmon begin to run in the streams many bear tracks are found in the sands along the shores. The brown bear grows to large size, and is usually avoided by prospectors, especially when accompanied by her cubs. These bears have attacked men without apparent provocation. On Crow Creek a new tent was torn to pieces and a supply of groceries scattered all about the place by a bear, apparently with no other motive than a love for destroying. The black bear is a timid animal and molests no one. A third variety, called the "glacier bear," is said to be seen occasionally, but whether this is a distinct species or simply a variety of black or brown bear the writer was unable to determine.

Moose and mountain sheep furnish all the fresh meat used by the miners. It is the belief of many on Kenai Peninsula that the moose has increased rather than decreased in numbers during the last ten years, and they attribute this to several causes. The number of wolves has been greatly reduced through the use of poison, and in this way many moose calves are saved which otherwise would have been destroyed. It is believed that the number is slowly increased by migration from the mainland. Finally, the region west of the Kenai Mountains is a very favorable country for moose, since it produces an abundance of the food they require, especially birch, poplar, and willow. Moose from Kenai Peninsula furnish some of the largest

antlers known, which are much in demand by trophy hunters. Undoubtedly many moose have been killed contrary to law, but it should be said that the miners are careful to observe the game laws and rarely take meat except when it is needed. Moose are most plentiful west of the Kenai Mountains, but signs were seen on Trail Lakes and Johnson Creek, around the heads of Canyon, Quartz, and Resurrection creeks, and along Kenai River. A few years ago mountain sheep were plentiful on the mountains east of Kenai Lake, east of Tustumena Lake, and in many other places, but are gradually being driven back from the more traveled ways. North of the arm, about the head of Eagle Creek, they may be seen at almost any time by those willing to climb the mountains in search of them. Spruce grouse and ptarmigan are not uncommon.

Fish are not plentiful in the smaller streams of the peninsula. Trout were taken at only a few places by the Survey party and none were seen in the glacier-fed streams of the Kenai Mountains. Salmon enter the streams flowing into Resurrection Bay and Cook Inlet in great numbers during the summer. There are three varieties, the king salmon, the silver salmon, and the red salmon, of which the first named is the largest and first to appear, but the less plentiful. They usually begin to run in Cook Inlet toward the middle of May, but did not appear in Resurrection Bay last summer till the middle of June. In September the shores of Lake Skilak and Kenai River were strewn with dead and dying fish, which furnished a feast for the bears, but gave rise to a very disagreeable odor. Canneries have been in operation at Kenai and Kasilof for many years and have shipped a great deal of fish. The one at Kenai was lately burned, however, and may not be rebuilt. Salmon formerly furnished the principal food of the natives of the peninsula, an average of about 190 pounds being prepared for winter use for each individual.

Codfish are found on the banks along the whole southern coast of Alaska, and were taken by members of our party at Kachemak Bay. Halibut are also taken in these waters.

CONCLUSIONS.

In conclusion it may be well to summarize briefly the favorable and the unfavorable conditions under which the prospector labors on Kenai Peninsula. The open season—that is, the length of time during which mining is not interfered with by cold weather—is longer than in either the Yukon country or Seward Peninsula. Compared with the interior of Alaska, ease of access is a condition favorable to the miner, as is also the lower cost of supplies and labor. When the region is considered as a whole, it may be said that the conditions tending to make hydraulic mining profitable are unusual in so far as water supply, water pressure, and thickness and extent of gravels are concerned. High stream gradients and consequent swift water aid in the disposal of tailings, and on the smaller streams sometimes make it possible to reach bed rock without great expense. An abundant supply of timber suitable for fuel and many other purposes is at hand and may be had for the cutting. On the other hand, gold in the stream gravels is very unevenly distributed, and in the high gravels has not been found sufficiently concentrated to be mined with profit. Although thickness of the high gravels is an advantage in hydraulic mining, yet the great thickness of gravels found along the larger streams, such as Resurrection and Sixmile creeks, is a decided disadvantage, especially when, as is always the case, the gravels are saturated with water, since it makes it impossible under ordinary circumstances to reach bed rock. Probably the most unfavorable condition encountered in rich as well as poorer deposits arises from the character of the gravels themselves, which are made up of an unusually large proportion of bowlders. These bowlders not only greatly increase the cost of mining as now carried on, but in many localities prohibit the use of labor-saving devices which might be employed if the gravels contained only a small amount of coarse material.

COAL FIELDS OF THE KACHEMAK BAY REGION.[a]

By Ralph W. Stone.

INTRODUCTION.

In continuance of the plan of the United States Geological Survey to investigate the mineral resources of Alaska, a party consisting of G. C. Martin, T. W. Stanton, and R. W. Stone spent the summer of 1904 on the coast of Cook Inlet and Alaska Peninsula. The investigation of the coal resources was assigned to the writer and opportunity was given to examine in detail the occurrence of coal beds in the Kachemak Bay and Port Graham regions. This report embodies the result of observations made in these two localities.

LOCATION.

Kachemak Bay is a large, northeastward-reaching arm of Cook Inlet which penetrates Kenai Peninsula near its southern end. The bay is funnel-shaped in outline, having a mouth 25 miles wide, extending from Anchor Point on the north to Dangerous Cape on the south. It is 35 miles long and tapers from a width of 6 miles at Homer to 3 miles at its head. Homer is at the outer end of Coal Point, a low, narrow spit composed of sand and gravel that projects 4 miles into the bay from the north shore. Its latitude is 59° 36′ 08″ and longitude 151° 23′ 37″. Homer was the scene of considerable activity several years ago, when 150 men were engaged in developing the coal field, but at present it contains only 2 men. Near the south entrance to Kachemak Bay, on its eastern shore, at the entrance of Seldovia Bay, is the village of Seldovia, which was the home of 7 whites and 75 natives in the summer of 1904. It is 12 miles southwest of Homer, and the first stopping point for steamers entering Cook Inlet.

Port Graham is a small bay 5 miles long that indents the west side of Kenai Peninsula south of the entrance to Kachemak Bay.

INVESTIGATION.

Cook Inlet ports can be reached from Seattle, Wash., in a week, by steamer direct or by transfer at Valdez. The party left Seattle May 22 and arrived at Seldovia May 29.

A trip to Port Graham, 8 miles southwest of Seldovia, was made in a 25-foot sloop. Homer is reached from Seldovia by steamer and was the writer's headquarters during the last three weeks of June.

[a] An abstract of this paper has been published under the heading Coal Resources of Southwestern Alaska, in Bull. U. S. Geol. Survey No. 259, 1905, pp. 151-171.

The work on the north shore of Kachemak Bay was begun in association with T. W. Stanton, who departed after three days for the west side of Cook Inlet. It was continued for two weeks with the assistance of Fred Reist, who served as oarsman and camp hand. The shore of the bay from Bluff Point eastward to a point 2 miles beyond Falls Creek (Pl. XIII), a distance of 28 miles, was traversed on foot, but camp was moved from point to point by means of a rowboat. A plane-table survey was made of the shore line from Coal Creek to Falls Creek, and of the south shore of the bay from Aurora to Gull Islands, opposite Homer. Later in the season E. G. Hamilton, topographer of the Moffit party, mapped the shore from Seldovia Bay nearly to Homer. These two maps, together with a plan of Seldovia Bay made by the writer, were combined with the Coast Survey chart and appear as Pl. XIII, accompanying this report.

In the prosecution of the work the writer received assistance from E. G. Wharf, of Seldovia, and many courtesies from S. T. Penberthy, of Homer.

MINING DEVELOPMENT.

HISTORY.

The existence of coal at Port Graham was reported by Portlock [a] in 1786, but it was not until the middle of the nineteenth century that coal mining was begun. In 1852 the Russian American Company undertook to mine coal at the locality discovered by Portlock and was actively engaged in its production for twelve years before Alaska was ceded to the United States. A long drift was run on one seam of coal and a shaft sunk to another. Coal was supplied to Russian steamers for a number of years, but it proved to be of low grade and was sold at a net loss. The enterprise was abandoned when ownership of the territory was transferred in 1867. A description of the developments at this locality will be given under the heading "Port Graham" (p. 66).

In 1888 the Alaska Coal Company began what was probably the first coal mining on the north shore of Kachemak Bay. Their operations, it is said, consisted in driving a tunnel on the Bradley seam near Fritz Creek, 6 miles north of Homer. It is not known how much work was done or whether any coal was shipped. The tunnel caved in long ago.

Lieut. R. P. Schwerin, U. S. Navy, on behalf of New York parties, took 200 tons from Kachemak Bay in 1891. This coal was shipped to San Francisco and submitted to a series of tests, the results of which are given on page 71. The results were not sufficiently satisfactory to warrant the development of the field under existing difficulties.

In December, 1894, the North Pacific Mining and Transportation Company began exploration in Eastland Canyon, about 14 miles northeast of Homer, under the supervision of M. B. Curtis. Three buildings and a short pier were erected at the mouth of the canyon, and a tramway was constructed from the pier to a tunnel driven on a coal seam half a mile up the canyon. The buildings are still standing, but the tramway, which follows the east bank of the creek, is undermined in many places. At least 650 tons of coal were taken out, lightered to the steamer *Theobald*, which lay at anchor in Bear Cove, and sent to San Francisco to be tested.

This company and the Alaska Coal Company continued prospecting in Eastland and McNeil canyons from 1894 to 1897. During this time two short tunnels were driven on a 4-foot coal seam 400 yards west of McNeil Canyon and 45 feet above the beach. This is called the Curtis seam. A short wharf and coal bins were built and still remain, though in a dilapidated condition. The horizontal dark bands seen in

[a] Portlock, Nathaniel, A Voyage to the Northwest Coast of America, London, 1789, pp. 102-110.


59°
40'
59°
20'

Pl. XVII, *A*, represent lignite beds. The outcrop of the Curtis seam is covered by a slide above the bin and appears only at the extreme right and left of the view. A frame house at the mouth of McNeil Creek and a log cabin at the mouth of Cottonwood Creek, built by these companies, were standing in 1904, but were out of repair.

Since 1899 the Cook Inlet Coal Fields Company has held possession of the most desirable part of the coal field on the north shore of Kachemak Bay. This is the portion which lies to the west and within 3 miles of the base of the long spit known as Coal Point.

Under the management of this company a large dock was built on the east side of Coal Point, where there is protected anchorage. A 42-inch gage railroad was constructed from the dock along the spit to the mainland, where it rises to the top of the bluff about 200 feet above the beach, and ends at Coal Creek. Two shafts were started and three tunnels were driven on a 6½-foot coal seam which outcrops in the sea bluff between Cooper and Coal creeks. Underground work was begun in the fall of 1899 by driving the first of these shafts, which is known as the Kirsopp slope, because it was excavated under the direction of John Kirsopp, an English mining engineer. This shaft had three compartments and was carried 125 feet, when it was discovered that the slope of the shaft was so nearly parallel with the dip of the coal

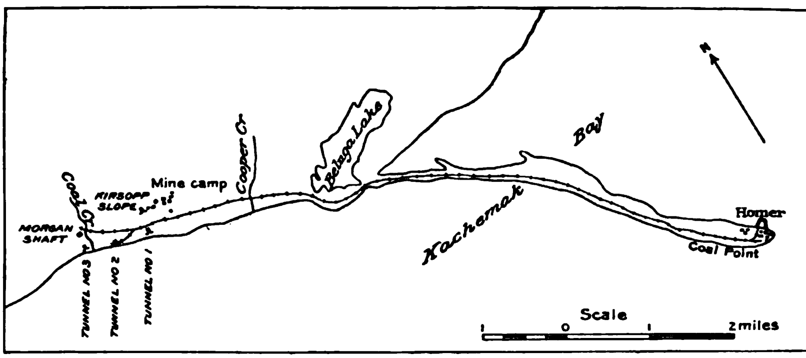


FIG. 5.—Sketch map showing location of Cook Inlet Coal Fields Company's operations.

that it would have to be driven nearly 1,800 feet to reach the coal. In 1900 tunnel No. 1 was driven in the face of the bluff on a seam of coal 6½ feet thick. It proved to be very wet and was abandoned. Tunnel No. 2, on the same seam, was driven 350 feet and had to be pumped to keep it dry. Coal was brought to the mouth of the tunnel in mine cars, dumped into a skip, and hoisted over the bluff by a square-framed derrick which spilled into a railroad car standing on the spur track. At the west end of the railroad a vertical 3-compartment shaft, known as the Morgan shaft and contemporaneous with tunnel No. 1, was sunk over 25 feet, and a tunnel was started on coal in the sea bluff near Coal Creek to connect with the shaft. This third, or Ray, tunnel was driven 125 feet when work at that end of the field was discontinued and efforts were concentrated on getting out coal from tunnel No. 2. During the winter of 1901-2 the mail steamer *Discovery* was supplied continuously with fuel and other vessels occasionally. All work on this property ceased in March, 1902, but the company holds possession by retaining a representative on the ground. No money or effort is being expended, however, in keeping the railroad or mine tunnels in repair. Eight buildings at the mine camp and 20 on Coal Point at Homer, which was the company's headquarters, are in good condition. Fig. 5 shows the location of the development work done by this company.

PRODUCTION.

The production of this region is estimated as follows:

Coal output of the Kachemak Bay region.

	Tons.
Port Graham	2,700
Kachemak Bay:	
Taken by Schwerin	200
Mined by Curtis	650
Taken by tug *Kodat*	15
On cars at Homer	80
Heap at Cook Inlet Coal Fields Company's mine	20
Sold at Homer	125
Total	3,790

TOPOGRAPHY.

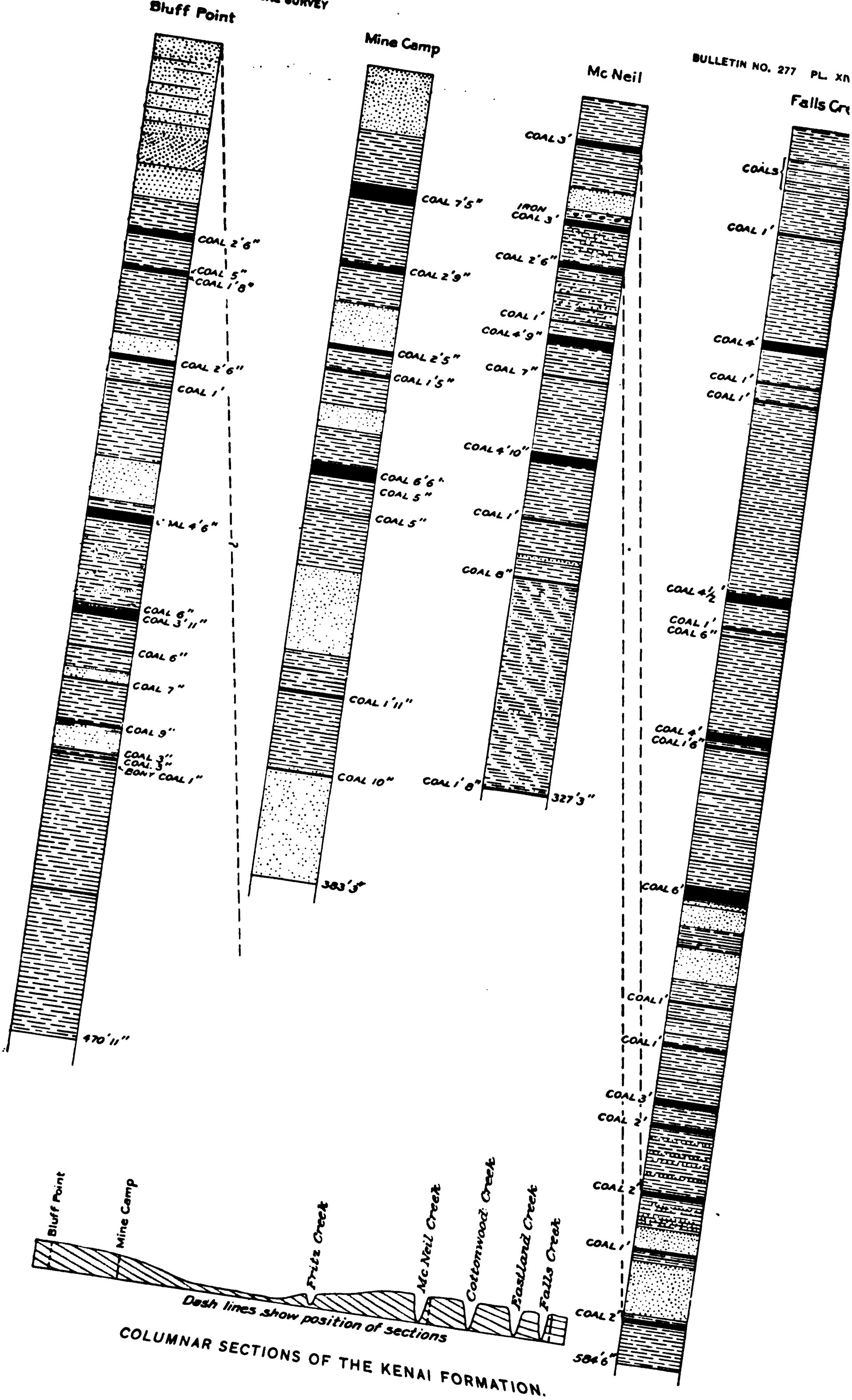
The mountain range which forms the backbone of Kenai Peninsula rises abruptly from the east and south shores of Kachemak Bay, its crest being marked by rugged snow-capped peaks having an elevation of 3,000 to 5,000 feet. In places a narrow belt of foothills covered with forest intervenes between the mountains and the shore. Cliff-like walls, sharp peaks, and narrow spurs are characteristic details of this section of the range, and six glaciers descend nearly to sea level and discharge their waters into the bay.

North of Kachemak Bay is the Kenai Plateau, which lies west of the Kenai Mountains and extends from this bay on the southwest to Turnagain Arm on the northeast. This area varies in width, but the average distance from the mountains to the shore of Cook Inlet is 25 miles, and its length is nearly 100 miles, so that it covers over 2,000 square miles. The plateau has its greatest elevation on Kachemak Bay and slopes gradually northward. The Kenai formation probably underlies the entire area, the lower and more densely consolidated coal seams being exposed in the sea bluff between Coal Point and Anchor Point. Thence northeastward the strata lie in broad, gentle folds, which finally carry the coal seams below sea level at Cape Kasilof.

The upper surface of the plateau is undulating and is cut by a number of westward-flowing streams, which, in the northern part of the area, have formed broad valleys in the soft Tertiary rocks. Many small shallow lakes are scattered over the surface, and in wet seasons large marshy areas are numerous. Meadows of considerable extent are interspersed through areas heavily wooded with spruce and poplar.

On the north side of Kachemak Bay the Kenai Plateau comes to the sea in steep bluffs ranging in height from 50 to 400 feet. The narrow beach at the base of these is kept free from talus by the constant action of the waves, and in some places is impassable at high tide. The bluffs are notched by sharp canyons, some of which are only a few hundred yards long, while others, such as those cut by McNeil, Cottonwood, Eastland, and Falls creeks, are from 1 to 2 miles long.

The shore line of the north and west side of Kachemak Bay is composed of long, straight, or slightly curved stretches of beach, usually overlooked by a bluff. Coal Point is the only marked projection. Shallow water is found all along the north shore, and when the tide runs out mud flats half a mile wide are exposed from Coal Point to the head of the bay. At Homer the range of tide varies from 16 to 28 feet. The east and south shore of the bay is indented by a number of bays and coves and flanked by numerous islands, of which Yukon, the blue-fox farm island, is the largest. Tutka Bay, which lies south of Yukon Island, is the deepest indentation, extending 8 miles. Seldovia Bay, lying near the southern entrance to Kachemak



COLUMNAR SECTIONS OF THE KENAI FORMATION.

Bay, is smaller, but more important, because a salmon stream empties into it and a village is located on its northern shore. This bay is shallow, and steamers do not go in farther than Seldovia, which is near the entrance. The streams flowing from Grewingk Glacier, which lies between two spurs of the Kenai Mountain Range, have built a broad delta out into the bay, and the terminal moraines of Wosnesenski and Doroshin glaciers unite in filling what would otherwise be a cove southeast of Homer. The south side of Kachemak Bay is navigable for steamers up to Bear Cove, where there is a protected anchorage.

GEOLOGY.

GENERAL STATEMENT.

The general geology of the Kachemak Bay region is discussed elsewhere in this report by Mr. Moffit (p. 16). On the south side of the bay it is complex and can be described briefly as exhibiting pre-Jurassic diabase and cherts, a lower Jurassic formation composed of tuffs, sandstone, and calcareous beds, and small isolated areas of Tertiary coal-bearing beds, known as the Kenai formation, lying unconformably on the other rocks. The Kenai formation makes the entire north shore of Kachemak Bay, and is overlain unconformably by gravels and clays of glacial origin. This paper is concerned only with the Kenai formation, which will be described in some detail.

KENAI FORMATION.

DISTRIBUTION.

The formation was named by Dall[a] from its occurrence on Kenai Peninsula, especially at Port Graham, and on the north side of Kachemak Bay. It first attracted attention by reason of the presence of coal on the north shore of Port Graham, where the formation is exposed for about 1,000 feet along the beach. In Kachemak Bay the Kenai formation is exposed continuously for 45 miles along the north shore from Anchor Point to the head of the bay, and it probably underlies an area of at least 2,000 square miles northeast of Kachemak Bay, known as Kenai Plateau. This formation occurs also at Tyonok, near the head of Cook Inlet, where there is a continuous outcrop along the beach for at least 4 miles;[b] its extent in this field has not been investigated. The Kenai formation has a wide distribution throughout Alaska.

CHARACTER.

The Kenai formation as exposed in Kachemak Bay is composed of soft, light-gray sandstones and clay shales, with numerous interspersed coal seams. Four partial sections of the formation, aggregating 1,763 feet of strata, are given on pages 60-66. These sections are represented diagrammatically in Pl. XIV, and show that coal seams ranging in thickness from a few inches to 7 feet are distributed throughout the portion of the formation represented. It appears also that 350 feet at the top of the Falls Creek section, which is the highest geologically, contain no sandstone, but are composed entirely of shale and coal. It can not be said with certainty that the lower portion of the formation is characterized by an abundance of sandstone and the upper part by a lack of it, although there is a suggestion that this may be the case. The sandstones are medium-grained, soft, light gray, sometimes iron stained, and occur in beds from a few inches to 30 feet thick. Cross-bedding was noted at one horizon. Some portions of the heavier beds of sandstone are hard and weather out in nodular blocks. In these blocks the best preserved fossil plants are sometimes found. In one locality lenses of grit occur in a sandstone mass. The pebbles in the grit are

[a] Dall, W. H., and Harris, G. D., Correlation papers—Neocene: Bull. U. S. Geol. Survey No. 84, p. 234.
[b] Eldridge, G. H., A reconnaissance in the Sushitna basin, Alaska: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, p. 21.

smaller than one-half inch in diameter and are mostly quartz. Dall[a] reports conglomerates in the Kenai series on Kachemak Bay, but the author found none in the portion he visited. Sandstone at places grades into sandy shale.

The shales of the Kenai formation on Kachemak Bay are all light-colored clay or mud rocks, grading on one side into arenaceous shale and on the other into clay. The shales are soft and crumbly on the outcrop, and when wet become plastic. Beds of clay that have been baked by the burning of coal seams are red and hard. Small blocks of gray, hard limestone were found at one locality and suggest that calcareous sediments in small amount may be contained in the formation. Limestone was not seen in place.

The abundant coal seams in the Kenai rocks of this field are all lignite. They vary in thickness from mere streaks to beds several feet thick. Eldridge[b] counted 36 seams along the beach at Tyonok, varying in thickness from a foot to 15 feet, and Kirsopp[c] figures 73 seams on the north shore of Kachemak Bay. Much of the Kachemak Bay lignite, especially that in the lower beds, is hard and glossy, clean to handle, and tends to break cubically. The higher beds, however, are dull and lighter and show more woody fiber.

THICKNESS.

The thickness of the formation exposed in Kachemak Bay has not been determined, and is almost impossible of determination because there are stretches over which the beds can not be traced. Anchor Point is near the base of the formation, but it is not known how far the coal-bearing rocks extend beyond the head of the bay, except that coal has been found 15 miles up Sheep Creek. Kirsopp[d] published a section from Anchor Point to the head of the bay, including 2,683 feet of coal-bearing measures. This section contains at least 126 feet of lignite in seams over 2 feet thick. The author did not go west of Bluff Point nor more than 3 miles east of Falls Creek, and can only guess at the thickness of the strata exposed between these two points. Estimated roughly, there probably are about 1,500 feet of strata between Bluff Point and the base of Coal Point. From Coal Point to McNeil Creek the dip is strong and 3,000 feet may be a low estimate. From McNeil Creek to the top of the bluff at Falls Creek at least 1,000 feet are exposed. Hundreds of feet of strata probably overlie the section measured at Falls Creek and outcrop in the bluff north of the head of the bay. The writer is inclined to think that 10,000 feet may not be a high estimate for the thickness of the Kenai formation in the Kachemak Bay field.

AGE.

The determination of the age of the Kenai is dependent chiefly on its fossil flora, which was originally described as Miocene, but is now considered more probably Upper Eocene.[e] Collections obtained by Dall from the shore immediately north of Coal Point, now deposited in the National Museum, were examined and in part reported on by Lesquereux.[f] This collection, with a more recent one obtained by Dall from Eastland Canyon, has recently been reexamined by F. H. Knowlton, who makes the verbal statement that it unquestionably belongs to the so-called Arctic Miocene flora of Upper Eocene age. Dall[g] has provisionally assigned the Kenai to the Oligocene, chiefly because its stratigraphic position is apparently similar to that of Oligocene beds in Oregon.

[a] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 789.
[b] Eldridge, G. H., op. cit., p. 21.
[c] Kirsopp, J., jr., Coal fields of Cook Inlet, Alaska: Trans. Inst. Min. Eng., London, 1901.
[d] Kirsopp, op. cit., p. 3.
[e] Alaska, geology and paleontology: Harriman Alaska Expedition, vol. 4, p. 162.
[f] Proc. U. S. Nat. Mus., vol. 5, 1882, pp. 443-449. The species there cited as from "Chugachik Bay" are from this locality.
[g] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 842.

The Kenai formation includes the following species of fossil plants: *Alnus corylifolia* Newby, *Fagus antipofi* Heer, *Fagus deucalionis* Ung., *Salix varians* Goeppert, *Salix raeana* Heer, *Ulmus sorbifolia* Goeppert, *Cornus orbifera* Heer, *Diospyros anceps* Heer, *Quercus Dallii* Lesq., *Corylus MacQuarrii* (Forbes) Heer, *Taxodium distichum miocenum* Heer, *Carpinus grandis* Ung., *Vaccinium reticulatum* Al. Br., *Andromeda grayana* Heer.

T. W. Stanton and the writer collected many of these species along the beach on the north shore of Kachemak Bay, from the mine camp near the base of Coal Point west to Bluff Point, but the collection was lost.

STRATIGRAPHIC RELATIONS.

It is reported[a] that fossil "oysters" (*Inoceramus*) are found at extreme low water off Anchor Point, but the report has not been verified. If it be true, the Kenai formation of upper Eocene age, is directly underlain by the same Cretaceous rocks that occur on the west side of Cook Inlet. In the vicinity of Seldovia Bay and at Port Graham the Kenai formation lies unconformably in steep-sided basins in the Lower Jurassic, or upon diabase of unknown age. The Kenai in the Cook Inlet region is overlain by unconsolidated gravels and clays.

For a more complete description of the stratigraphic relations of the Kenai formation in this vicinity, reference should be made to the accompanying paper by Mr. Moffit.

DEFORMATION.

The Kenai formation in Kachemak Bay and vicinity is very gently folded and has suffered but little faulting. North of the bay four broad folds, which probably trend generally east and west, are described by the coal-bearing beds under the Kenai Plateau. Along the shore of the bay the strike is generally about N. 65° W. and the dip is northeast at low angles. The few faults which were noted seemed to be small.

THE COAL.

OCCURRENCE AND DEVELOPMENT.

The Kenai formation, which carries the coals found on the east side of Cook Inlet, outcrops along the entire north shore of Kachemak Bay and in a small cove at Port Graham. The coal beds are not confined to any one definite horizon in the formation, but seem to be rather evenly distributed throughout many hundreds of feet of strata. In this region they are all lignites, or at least lignitic in character.

In discussing the occurrences of the Kenai formation, localities on the north shore of Kachemak Bay will be described in geographic order eastward from Anchor Point.

NORTH SIDE OF KACHEMAK BAY.

Anchor Point.—It is reported that several seams of coal outcrop between high and low tide one-half mile south of Anchor Point. One seam[b] is said to be 8½ feet thick and harder than coal found elsewhere in this bay. These coal beds off Anchor Point are probably in the lowest Kenai exposed in Kachemak Bay. Coal also occurs a few feet above high tide at the mouth of Travers Creek, 3 miles east of Anchor Point. The seam is 5 feet thick, and the middle portion, about 2 feet thick, is a hard, shiny coal which is considered by those who have used it[c] to be of higher grade than that found farther east. Some of it is said to melt and cake like Pittsburg coal when ignited. This coal is bright, blocky, ignites quickly, and does not soil the hands.

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[a] Dall., op. cit., p. 788.
[b] Reported verbally by Mr. Fred Reist, prospector.
[c] Messrs. Fred Reist and Fred Barker, prospectors.

Bluff Point.—At Bluff Point, 12 miles northwest of Homer, a cliff has been formed by a landslip extending parallel to the coast for a mile. In this cliff the Kenai formation is beautifully exposed. The top of the bluff, which is one-eighth mile back from the beach and 600 feet high, is a broad meadow bordered with spruce. A section of the formation measured at this point by T. W. Stanton and the writer is as follows:

Partial section of Kenai formation at Bluff Point.

	Ft.	In.
Sandstone with thin coal streaks	40	0
Massive cross-bedded sandstone	20	0
Massive sandstone	15	0
Arenaceous shale	15	0
Coal	2	6
Bluish clay shale	15	0
Coal	0	5
Carbonaceous clay shale	1	3
Coal	1	8
Clay shale	30	0
Sandstone	10	0
Coal	2	6
Clay shale	10	0
Coal	1	0
Clay shale	35	0
Sandstone	20	0
Clay shale	5	0
Coal (section below)	4	6
Clay shale with sandstone lense	40	0
Coal	0	6
Clay shale	0	10
Carbonaceous shale	0	10
Coal (section below)	3	11
Clay shale	15	0
Bony coal	0	6
Clay shale	10	0
Sandstone	5	0
Coal	0	7
Clay shale	20	0
Coal	0	9
Clay shale	1	3
Sandstone	10	0
Clay shale	1	0
Coal	0	3
Clay shale	2	0
Coal	0	3
Clay shale	3	6
Bony coal	0	1
Clay shale	60	0
Sandstone lenses	0	10
Clay shale	65	0
Beach	...	..
Total	470	11

In this bluff the strata strike about N. 65° W., or parallel with the coast line, and dip northeast. The sandstones are medium coarse grained, soft, quartzose, and often somewhat iron stained. Shale which is so soft that it crumbles readily forms the greater part of the bluff. Eighteen feet of coal in 13 seams ranging in thickness from 3 inches to 4½ feet are interbedded with the shale and sandstone, all of black, glossy lignite. Detailed measurements of the two largest seams in the section given above are as follows:

Section of coal seam at Bluff Point.

	Ft.	In.
Coal and shale	0	10
Coal	0	11
Shale parting	0	3
Coal	0	9
Shale parting	0	1
Coal	0	3
Shale parting	0	2
Coal	1	3
Total	4	6

A thinner seam 42 feet below the one just given and about 180 feet above the beach has about the same amount of coal with less waste.

A. SITE OF COOK INLET COAL FIELDS COMPANY'S TUNNELS NEAR THE MINE CAMP.

B. KENAI FORMATION NEAR BLUFF POINT.

The dark band in the bluff is a bed of coal.

Section of coal seam at Bluff Point.

	Ft.	In.
Coal	2	6
Shale parting	0	2
Coal	1	3
Total	3	11

Pl. XV, *B*, gives a general view of the coal seams in the cliff near Bluff Point. An appearance of step faulting is due to a number of sharp gullies which in the perspective view hide a portion of the outcrop of the thick coal seam.

Mine camp.—That portion of the north shore which lies just west of Coal Point may be called the mine-camp district. It lies at the west end of the Cook Inlet Coal Fields Company's railroad, 7 miles from Homer. The coal-bearing series is exposed in a cliff which is 250 feet high at a point three-fourths mile west of the mine camp but which decreases in elevation toward the east and disappears before reaching the base of Coal Point. A view of this cliff showing a number of coal seams is given in Pl. XV, *A*.

A section whose base is as high stratigraphically as the top of the one at Bluff Point was measured near the mine camp. The lower part was obtained at the point near Coal Creek and the upper part one-half mile farther east. The combined section is as follows:

Partial section of Kenai formation at the mine camp, Kachemak Bay.

	Ft.	In.		Ft.	In.
Sandstone	30	0	Clay shale	3	7
Clay shale	25	0	Coal	0	5
Coal (section below)	7	5	Clay shale	12	0
Clay shale	30	0	Coal	0	5
Coal (sample No. 3)	2	9	Clay shale	26	0
Shale	16	0	Sandstone	40	0
Sandstone	20	0	Clay shale and coal streaks	18	0
Coal (section below)	2	5	Coal	1	11
Clay shale	9	1	Clay shale	34	0
Coal	1	5	Sandstone	2	0
Clay shale	15	3	Coal	0	10
Sandstone	11	10	Sandstone to beach	50	0
Clay shale	16	0			
Coal (Cooper seam, sample No. 4)	6	6	Total	382	10

Between the two places where the section was measured there is some variation in the character and sequence of the strata. At the point the section seems to be composed more largely of sandstone, and the coal 42 feet above the Cooper seam appears to be absent. The sandstones are only partly consolidated and are less resistant to weathering than the coal, while the shales, which are soft and crumbly, sometimes contain hard lenses and a few clay ironstones.

Exposed in this cliff are three coal seams, whose position in the preceding section can be recognized by their total thickness. The first and thickest seam, which is more than 50 feet below the top of the bluff where the section was measured at the end of the railroad spur, is composed of the following beds:

Coal seam at the mine camp, Kachemak Bay.

	Ft.	In.
Bony coal and clay	2	0
Clay shale	1	8
Coal	2	6
Clay parting	0	2
Coal	1	1
Total	7	5

The next section is the third seam from the top of the bluff:

Coal seam at the mine camp, Kachemak Bay.

	Ft.	In.
Coal	1	7
Clay parting	0	4
Coal	0	6
Total	2	5

Following is the section of the Cooper seam, on which three tunnels were driven by Cook Inlet Coal Fields Company:

Cooper seam at the mine camp, Kachemak Bay.

	Ft.	In.
Coal	3	0
Clay parting	0	½
Coal	1	11
Clay parting	0	1½
Coal	1	5
Total	6	6

An outcrop of the Cooper seam is shown in Pl. XVI, *B*.

Other seams of coal lying lower than those given in the section on page 61 are found below high tide at the point near Coal Creek. The first one outcrops about 350 feet from the base of the point and appears to be about 6 feet thick. It has an upper bench at least 15 inches and a lower one 30 inches thick. The strike of this seam across the beach is N. 58° W. and the dip north. The interval between this coal and the base of the formation section given above (p. 61) seems to be occupied by sandstone. Outcropping parallel with it and 130 feet farther offshore is another seam, which is 4 feet 5 inches thick and strikes N. 80° W. Still farther offshore and exposed only at very low tide is a 1-foot seam.

The coal in these seams is hard, compact, glossy lignite. It is clean, does not smut the hands, and tends to break in cubical fragments. When exposed to the weather its high content of moisture causes it to slack down to fine chips. Carloads of coal that have been standing at Homer for three years are shown in Pl. XVI, *A*. Only a small amount of disintegration is apparent in the picture, but the blocks are so deeply weathered that they easily break to pieces. The composition of these coals will be discussed later.

The rocks dip slightly to the east along shore and at an angle of 15° or 20° into the bluff. There are nine coal seams in the mine camp bluff, having a total thickness of 24 feet, as shown in the section on page 61. The smallest seam in the section is 4 inches and the largest 7 feet 5 inches thick.

This portion of the Kachemak Bay coal field, lying just west of Coal Point, was the scene of considerable development work by the Cook Inlet Coal Fields Company, as described on page 55.

Fritz Creek.—The first prominent coal locality inside Coal Point is at the outcrop of the Bradley seam on the beach halfway between Fritz Creek and the base of the spit. The Bradley seam runs from the bluff obliquely across the beach with an average dip of about 15° N. Although this seam aggregates about 7 feet, there is only 18 inches of clear coal, the greater portion of the bed being made up of thin seams interbedded with leaf-bearing shale. It is said[a] that the Alaska Coal Company explored this seam in February, 1888, and that Mr. J. A. Bradley drove a tunnel at this place several years ago which is now caved in. Part of the outcrop of the

[a] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 791.

A. CARLOADS OF LIGNITE AT HOMER AFTER THREE YEARS' EXPOSURE TO THE WEATHER.

B. OUTCROP OF COOPER SEAM.

The left foot of the man is at the floor of the seam; his right hand indicates the main parting; the head of the pick touches the roof.

Bradley seam is covered at high tide, but at low tide the water runs out half a mile or more, exposing broad mud flats, into which the coal outcrop can be traced. The Dall and Becker party in 1895 broke out about 15 tons of this coal with crowbars and used it for steam purposes and galley fuel on the steam tug *Kodiak*.

Near Fritz Creek the sea bluff is about 50 feet high. The top is a fairly level belt of wooded land, which reaches back to a bluff several hundred feet high and 2 or 3 miles distant from the shore. The clean cliffs of this higher bluff show numerous coal seams, some of which are usually on fire. Being harder than the sandstone and shale with which they are interbedded, the lignite seams always form small ledges in the cliffs and in the beds of streams cause cascades. This is well illustrated in Pl. XVII, *B*, reproduced from a photograph taken on the north shore of Kachemak Bay, near Cottonwood Creek, where a rill is seen jumping down over 7 small coal seams in the sea bluff.

From Fritz Creek eastward to McNeil Creek the coal seams exposed in the sea bluff are mostly thin. In one stretch of 2 miles the section is almost entirely sandstone, hard nodular blocks of which lie along the beach and often show fossil leaves. In places a few feet of pebble sand or grit is interbedded with the sandstone. This barren section soon dips below sea level, and where the bluff becomes higher gives place to a 100-foot section containing half a dozen lignite seams, the thickest of which is 27 inches. The highest bed in the bluff soon comes down to the beach, the dip along shore being 8° or 10°.

McNeil Creek.—Ten miles northeast of Homer a small stream, known as McNeil Creek, has cut a sharp canyon through the bluff, making excellent exposures of the formation. Four hundred yards west of the canyon two short tunnels were driven on a 4-foot coal seam a few feet above the beach. This work was done ten years ago by Mr. M. B. Curtis, and the seam is called the Curtis seam. (Pl. XVII, *A*.)

Section of Curtis seam, Kachemak Bay.

	Ft.	In.
Coal	0	7
Parting	0	¼
Coal	0	9
Parting	0	¼
Coal	0	6½
Parting	0	1
Coal	0	8
Parting	0	¼
Coal	1	5
Total	4	1¼

Iron-stained sandy clay forms the roof, and the floor is of gray clay. Timbering would be necessary to avoid caving in if coal were taken out to any extent. The coal is compact and tends to break cubically. In the bluff above the Curtis seam there are three other seams, separated by thick beds of clay or soft sandstone. The lowest of the three is nearly 4 feet thick, and was measured about 300 yards up the canyon and 35 feet above high tide, at a spot where it outcrops and causes a small cascade. This outcrop is illustrated in Pl. XVIII, *B*, and the section is given below:

Section of coal in McNeil Creek, Kachemak Bay.

	Ft.	In.
Coal	0	8
Parting	0	2
Coal	0	7
Parting	0	2
Coal	2	4
Total	3	11

A short distance farther up the creek and 60 feet above tide a 20-inch coal seam causes another cascade. From this seam to the top of the bluff the section measures 327 feet and contains 21 feet 4 inches of coal. Four of the coal seams are 3 or more feet thick.

The section of the Kenai formation exposed along this creek, as measured by the writer, is given below:

Partial section of Kenai formation in McNeil Canyon.

	Ft.	In.		Ft.	In.
Top of bluff.			Clay shale	14	0
Clay shale	20	0	Coal	0	7
Coal	3	0	Clay shale	36	0
Clay and coal streaks	20	0	Coal (section below)	4	10
Sandstone	10	0	Clay shale	26	0
Clay and ironstone	5	0	Coal	1	0
Coal	3	0	Clay shale	16	0
Sandy clay	17	0	Sandstone	2	0
Ironstone	0	3	Clay shale	8	0
Coal	2	6	Coal	0	8
Clay, coal streaks, and sandstone nodules	25	0	Clay and sandstone	99	0
Coal	1	0	Coal	1	8
Clay shale	6	0			
Coal (section below)	4	9	Total	327	3

Two of the coal beds exposed here are over 4 feet thick. The details follow:

Section of coal seams in McNeil Canyon.

	Ft.	In.
Coal	2	0
Clay	0	7
Coal	0	5
Clay	0	2
Coal	0	4
Clay	0	2
Coal	0	2
Clay	0	3
Coal	0	8
Total	4	9
Coal	0	6
Clay	1	0
Coal	3	4
Total	4	10

All of the coal in this canyon is bright, glossy lignite, of light weight, having a cubical fracture, and a tendency to slack on drying.

In 1891, Lieut. R. P. Schwerin, U. S. Navy, prospected for coal in this vicinity and took out 200 tons, 50 tons each from four localities, which were shipped to San Francisco and submitted to a series of tests. One of the 50-ton samples was taken from McNeil Canyon.

Cottonwood Creek.—Cottonwood Creek is 2 miles northeast of McNeil Creek and opposite Aurora. It enters the bay by a sharp canyon, which is not so narrow as that of McNeil Creek and has no distinctive landmark, the roofless log cabin at the mouth being hidden among the trees. The dip of the strata between the two creeks

A. OUTCROP OF CURTIS SEAM, RUINS OF WHARF AND BUNKER.

B. CASCADES OVER LIGNITE SEAMS IN SEA BLUFF.

is slight. A coal seam halfway up the bluff at the mouth of McNeil Creek can apparently be traced to a bed 50 feet above tide on Cottonwood Creek. This correlation is not certain, however, because there appears to be a fault about halfway between the two canyons, and a landslip at the west side of Cottonwood Creek also displaces the strata.

At a distance of three-fourths of a mile from its mouth Cottonwood Creek runs nearly parallel with the shore. A mile from the bay the small branches cascade from a height of 500 feet, and the main stream cascades 200 or 300 feet not more than 2 miles from its mouth. In the cascades the strata are well exposed, the coal seams making the ledges over which the water falls. No coal seams over 2 feet thick were seen in the canyon below an elevation of 300 feet. At this height a bed outcrops which appeared at a distance to be 3 feet thick. The coal in this canyon is lighter, perhaps less compact, and dull. Some of it preserves its woody structure so perfectly that it will split in slabs and chips like wood.

Clay forms a considerable part of the section in this canyon. A few limestone cobbles, 6 to 8 inches thick, showing yellowish white on the weathered surface and gray inside, were noticed in the stream bed. The limestone is hard, rings under the hammer, and contains carbonaceous spots or woody fragments. It was not found in place. A quantity of iron carbonate nodules, noticeably heavy and brown, were also seen in a layer 5 inches thick overlying a coal seam about one-third mile from the beach.

Eastland Creek.—This creek is 1½ miles beyond Cottonwood Creek. A sandstone layer conspicuous near the top of the bluff at Cottonwood Creek seems to be almost as high above the beach at Eastland Creek. The tide runs out nearly a mile, but high tide reaches the base of the bluff and keeps it free from talus. At the mouth of the canyon there are the ruins of three cabins, a short dock, and a small tramway which runs up the creek 2,000 feet. Active mining exploration work was done here by M. B. Curtis, engineer in charge for the North Pacific Mining and Transportation Company from 1895 to 1897. One-half mile up the canyon a coal seam shows the following section:

Section of coal in Eastland Canyon, Kachemak Bay.

	Ft.	In.
Coal	1	3
Clay	0	2
Coal	0	4
Clay and coal	1	3
Coal	2	6
Total	5	6

This seam is about 250 feet above tide, has a sandstone roof and clay floor, and dips 4° N. A tunnel driven at the end of the tramway on the seam is choked at the mouth and access was not obtained. Measurement was made and a sample taken where the creek cascades over the outcrop. On the east fork of the creek a coal seam 3 feet 2 inches thick is found at an elevation of 360 feet, and a vertical fault trending N. 70° W. The coal here has a duller fracture and sound under the hammer than have those farther down the bay. Some of it seems to resemble brown coal.

Falls Creek.—One mile northeast of the mouth of Eastland Creek a small stream enters the bay by a deep canyon. The name Falls Creek is given by the writer because there is a 20-foot waterfall within a few rods of the beach. This fall, like many in the streams on the north side of Kachemak Bay, is caused by a coal seam. The face of the bluff on the east side of Falls Creek is bare and light colored, and is noticeable for a long distance. A large number of coal seams 1 to 2 feet thick which

appear in the bluff (see Pl. XVIII, *A*) are also exposed in the bed of the stream. The first is 2 feet thick and causes the waterfall. There is a 3-foot seam containing 6 inches of clay at an elevation of 90 feet. Eighty feet higher is a 6-foot seam, the upper half of which consists of interbedded layers of clay and coal. A 4-foot seam, 240 feet above tide, has a 4-inch clay parting 3 feet from the floor, and another seam at an elevation of 300 feet is 4½ feet thick with only one parting, which is 5 inches thick and 30 inches from the floor. There are several other beds above this, the thickest of which is 4 feet. The coal in this canyon is fairly solid, but light and woody; it has a dull fracture and resembles that in Eastland and Cottonwood canyons. The more woody character and better preservation of the vegetable fiber in the coals from McNeil Creek eastward give the impression that they are as a whole of a different quality and a lower grade than the lignites west of Coal Point.

The section below was measured from the plateau at an elevation of about 520 feet down to the beach. It is higher stratigraphically than the section in McNeil Canyon given on page 64, and it is possible that the two sections overlap about 100 feet.

Partial section of Kenai formation in Falls Creek Canyon.

	Ft.	In.		Ft.	In.
Clay shale	15	0	Sandstone	10	0
Shale and 4 thin coals	15	0	Clay and coal streaks	10	0
Clay shale	20	0	Sandstone	15	0
Coal	1	0	Clay shale	10	0
Clay shale	50	0	Coal	1	0
Coal	4	0	Clay shale and coal streaks	20	0
Clay shale	15	0	Coal	1	0
Coal	1	0	Clay shale and coal streaks	25	0
Clay shale	8	0	Coal	3	0
Coal	1	0	Clay shale	8	0
Clay shale	90	0	Coal	2	0
Coal	4	6	Clay shale and sandstone	30	0
Clay shale	12	0	Coal	2	0
Coal	1	0	Sandy clay shale	15	0
Clay shale	3	0	Sandstone	10	0
Coal	0	6	Coal	1	0
Clay shale	45	0	Clay and coal streaks	5	0
Coal	4	0	Sandstone	25	0
Clay shale	2	0	Clay shale	2	0
Coal	1	6	Coal	2	0
Clay shale and coal streaks	65	0	Clay shale	20	0
Coal	6	0	Total	584	6
Clay and shale	1	0			
Carbonaceous sandstone	2	0			

From Falls Creek to the head of the bay the strata dip at a low angle to the north. Clay beds baked hard and red by the burning coal seams color the upper part of the bluff for some distance.

The coal-bearing formation is visible in the bluffs as far as the head of the bay, and a 3-foot seam of coal is reported 15 miles beyond the head of the bay, 200 feet above tide on Sheep Creek.

PORT GRAHAM.

Lignite beds of the Kenai formation are exposed near the mouth of Port Graham. This small bay on the east side of Cook Inlet is long and narrow, penetrating about 8 miles. Dangerous Cape marks the northern entrance, and the native village of

A. KENAI FORMATION AT THE MOUTH OF FALLS CREEK.

B. OUTCROP OF LIGNITE SEAM IN McNEIL CREEK.

Alexandrovsk stands at the southern entrance. The small cove at Alexandrovsk is sometimes called English Bay to distinguish it from Port Graham. The cove on the north side of Port Graham, under Dangerous Cape, was called Coal Bay by Portlock, who discovered coal here in 1786. [a]

At the western end of a crescent-shaped beach behind Dangerous Cape is a low bluff exposing sedimentary rocks lying nearly horizontal between two masses of igneous rock about 1,000 feet apart. The series is composed of sandstone, clay shale, and coal, and appears to have been deposited unconformably in a steep-sided erosion valley in the older rocks. This section at Port Graham must be considered one of the type localities of the Kenai formation, which was the name giv. n by Dall to the coal-bearing Tertiary beds "best exhibited on the shores of Kachemak Bay, Kenai Peninsula, Cook's Inlet," because it was one of the earliest describe l localities and because it yielded a large proportion of the so-called Miocene flora described by Heer, [b] which has furnished the paleontologic characterization of the formation. At the time of the writer's visit the fossiliferous strata were not accessible, and the following statement concerning the fauna and flora is quoted from Dall: [c]

> The plants are all terrestrial or fresh-water species. One of the most common is a species of *Trapa* represented by many fruits. With them are found *Unio* (*Margaritana*) *onariotis* Mayer, a species probably related to *Margaritana margaritifera* L.; *Amicola abavia* Mayer; and *Melania* (*Goniobasis?*) *furuhjelmi* Mayer, together with elytra of a beetle described by Heer under the name of *Chrysomelites alaskanus*. Among the plants are both Coniferæ and broad-leaved trees, the total number of species amounting to forty-four. The deposit appears to have been formed at the bottom of a lake. The leaf-bearing strata crop out below the level of the sea and are accessible only at extreme low water.

Two outcrops of coal were seen, one on the beach between tides, and the other at high-tide mark, near the west end of the gravel beach. A tunnel driven on the coal at the latter outcrop is now caved and inaccessible. At the mouth of the tunnel there are between 8 and 9 feet of coal, some of which is good and some bony. Clay underlies the bed and the roof is shaly sandstone. On top of the bluff, a short distance back from the beach and about in line with this tunnel, is the mouth of a large shaft. Its dump is small and shows no coal, from which it is concluded that sinking ended at no great depth. On the beach at the end of a log crib is the framework of a 6 by 10 foot shaft, in one corner of which are hollow upright logs which may have been pump columns. A Russian miner, who lived for many years at Seldovia and died there in May, 1904, at the age of about 95, said he had worked in this shaft. As he remembered it, the shaft was 180 feet deep and passed through 5 seams of coal, of which the first was about 5 feet thick, the three succeeding ones smaller, and the fifth, at the bottom of the shaft, about 9 feet thick. [d] Nothing is known of the workings in this shaft.

Ruins of several large log buildings situated on the hill a few hundred yards back from the shafts are hidden in the long grass and second growth of spruce which covers the top of the bluff. A blacksmith shop, tool house, church, cook house, and barracks were recognized. Connection between these log buildings and the abandoned mine is shown by their proximity, and by the quantity of iron ax and pick heads and other tools and machinery found in the buildings. At low tide a long line of large stone blocks, apparently the ruins of a stone pier, can be seen extending from the mouth of the tunnel at least 100 yards into the bay.

Russian occupancy of this bay extended from 1855 to 1867. In April, 1855, the bark *Cyane*, Captain Kinzie, left San Francisco for Port Graham, where miners and machinery were landed. [e] Mining operations continued about ten years and supplied Russian steamers with coal. Bancroft [f] says of the operations in this bay:

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[a] Portlock, Nathaniel, A Voyage to the Northwest Coast of America, London, 1789, pp. 102-110.
[b] Heer, Flora fossilis Alaskana, 1869.
[c] Op. cit., p. 787.
[d] Information furnished verbally by E. G. Wharf, Seldovia.
[e] Dall, op. cit., p. 786.
[f] Bancroft, H. H., History of Alaska, p. 694.

In 1857 shafts had been sunk and a drift run into the vein for a distance of nearly 1,700 feet, nearly all of which was in coal. During this and the three following years over 2,700 tons were mined, the value of which was estimated at nearly 46,000 roubles, but the result was a net loss. The thickness of the vein was found to vary from 9 to 12 feet, carrying 70 per cent of mineral, and its extent was practically unlimited; but the coal was found to be entirely unfit for use of steamers, and a shipment of 500 tons forwarded to San Francisco realized only 12¼ roubles per ton, or considerably less than cost.

It is likely that as the shafts increased in depth water came in faster than primitive pumps could handle it, and in addition, as the coal was found to be an inferior quality of lignite, operations were discontinued. The mine was finally abandoned when Alaska was sold to the United States.

Port Graham coal is lignite—black, brilliant, clean to handle, and with slabby cleavage. The blocks into which it breaks are fairly strong, although like most lignites they lose luster and slack on long exposure to the weather. It burns well and makes little ash. An analysis is given on page 70. The limited extent of the coal beds, their position below sea level, and other disadvantages make this field of little more than historic interest.

SOUTH SIDE OF KACHEMAK BAY.

At a number of localities on the south side of Kachemak Bay there are sedimentary rocks, supposedly of the Kenai formation. In a high sea bluff about 2 miles north of Seldovia there is an exposure of finely laminated clays and partly indurated sandstone, which rest unconformably on diabase. A few plant impressions found in the clay and the conspicuous contact near the bottom of the bluff show that these beds are the base of the Kenai formation.

According to Mr. H. D. Reynolds, of the Reynolds Alaska Development Company, and Mr. Ritchie, of Yukon Island, there is coal on the mainland east of Yukon Island and north of Sadie Cove. Mr. Reynolds saw abundant float, but did not find the coal in place. It is not unlikely that some of the lower members of the Kenai formation may be caught in the mountain and thus account for the presence of the coal.

At a point 2 miles southwest of Seldovia Bay tilted Jurassic tuffs and sandstones abut against horizontal conglomerates. A mile farther along shore the Jurassic beds are found again. The horizontal conglomerates have a very youthful appearance, being only partly consolidated, and probably belong to the Kenai formation. They seem to have been deposited unconformably in steep-sided, comparatively narrow valleys in the older rocks. No fossils were found in them, and the character of the beds seemed unfavorable for the preservation of any. No other occurrences of the Kenai formation are at present known in the vicinity of Kachemak Bay.

CHARACTER OF THE COAL.

ANALYSES.

A study of analyses of samples throws light on the character of the coal and forms a basis of comparison between different seams and fields. Five analyses of Kachemak Bay coals were made by George Steiger in the chemical laboratory of the United States Geological Survey for W. H. Dall in 1895, and were published in the latter's report on coal and lignite of Alaska. Dall's samples were "taken from the seam and tied up in bags of stout duck, and analyzed immediately on arrival at headquarters."[a] This method of treatment resulted in a very appreciable loss of moisture, and for that reason the analyses will not be repeated here. Six samples were taken at Kachemak Bay by the writer and analyzed in the same laboratory by W. T. Schaller.

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[a] Dall, op. cit., p. 827.

These samples were taken under greatly differing conditions, but all are intended to represent the marketable portion of the seams. One was taken inside a tunnel, another below high tide, and the others on the outcrop, which in some cases was dry and in others a stream bed. Each sample was washed piece by piece and dried several hours in the open air before crushing and quartering. They were packed in tin cans with tight covers, so there was little chance for evaporation during the six months which elapsed before they were analyzed. Two sets of analyses were made, one from samples ground in a coffee mill and the other from specimens ground to powder in an agate mortar. The analyses of the coarse-ground samples are believed to represent more closely the condition of the coal as it would be mined and marketed, and are given below:

Analyses of coarse-ground Kachemak Bay coal.

No. of sample.	Locality.	Moisture.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3	Mine camp, below hoist	20.87	40.71	33.29	5.13	0.36
4	Mine camp, No. 3 tunnel	19.26	43.95	28.74	8.05	.32
7	Mine camp, below tide	19.22	41.22	31.96	7.60	.38
8	Curtis seam, McNeil Canyon	18.92	37.62	28.59	14.87	.46
9	McNeil Canyon	21.54	39.10	30.26	9.10	.34
10	Eastland Canyon	19.29	40.31	33.11	7.29	.27

Sample No. 3 in the above table was taken from the outcrop of the 2-foot 9-inch seam near the end of the railroad spur at the mine camp; No. 4 came from 50 feet inside of tunnel No. 3; No. 7 represents 30 inches of a 4½-foot bed occurring below tide about 500 feet offshore at the point west of Coal Creek; No. 8 was cut from the outcrop of the Curtis seam 400 yards west of McNeil Canyon; No. 9 was from a 4-foot seam found 300 yards from the beach up McNeil Canyon; No. 10 was from the lower 30-inch bench of a 5½-foot coal seam on which a tunnel was driven in Eastland Canyon.

Analyses of the same 6 samples ground fine showed a much lower percentage of moisture, and in that respect compare closely with those published by Dall for the same locality. The loss was due probably to evaporation during manipulation in a finely pulverized condition.

The averages of the 6 analyses given above, of the 6 analyses of the same fine ground, and of the 5 analyses published by Dall are shown in the following table:

Average analyses of Kachemak Bay coal.

	Moisture.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Six analyses given above	19.85	40.48	30.99	8.67	0.35
Same material fine ground	11.07	44.90	34.39	9.63	.39
Five analyses given by Dall	11.59	49.03	31.64	7.73	.35

These analyses show that this lignite has a low percentage of sulphur and not an excessive amount of ash. It is probable that the marketed coal would contain 15 or 20 per cent of moisture.

The writer took a sample of Port Graham coal from blocks dug at the outcrop between tides. It was washed to remove dirt and barnacles and packed in a tight tin can. On arriving at the United States Geological Survey laboratory it was analyzed by W. T. Schaller, with the following result:

Analysis of Port Graham coal.

	Per cent.
Moisture	16.87
Volatile matter	37.48
Fixed carbon	39.12
Ash	6.53
Sulphur	.39

From this analysis it appears that the content of moisture is high and the ash moderately low.

The following table offers a comparison of Kachemak Bay lignites with coals from other points on the Pacific coast:

Averages of analyses of Pacific coast coals.

No.	Locality.	Moisture.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Fuel ratio.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
6	Kachemak Bay, Cook Inlet	19.85	40.48	30.99	8.67	0.35	0.76
1	Port Graham, Cook Inlet	16.87	37.48	39.12	6.53	.39	1.04
2	Unga Island, Shumagin Islands[a]	10.92	53.36	28.25	7.47	1.36	.53
5	Bering River, Controller Bay[b]	2.18	12.76	74.33	10.73	.93	5.82
12	Cape Lisburne (Jurassic)[c]	9.46	38.42	46.83	5.24	.38	1.21
3	Cape Lisburne (Carboniferous)[c]	3.66	17.47	75.94	2.92	.96	4.46
5	Comox, Vancouver Island[d]	1.25	26.87	58.74	11.76	1.38	2.19
4	Nanaimo, Vancouver Island[d]	2.10	31.68	54.47	8.09	.66	1.57
10	Washington[e]	4.43	31.60	56.01	7.45	....	1.77
17	Coos Bay, Oregon[f g]	10.22	44.19	38.91	7.35	.90	.88

[a] Dall, W. H., Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 828.
[b] Martin, G. C., Bering River coal fields: Bull. U. S. Geol. Survey No. 225, p. 374.
[c] Collier, A. J., Geology and coal resources of the Cape Lisburne region, Alaska: Bull. U. S. Geol. Survey No. 278, p. 48.
[d] Annual Report of Minister of Mines, British Columbia, 1902, p. H-262.
[e] Smith, G. O., Coal fields of the Pacific coast: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, p. 490.
[f] Smith, G. O., op. cit., p. 510.
[g] Diller, J. S., Geology of northwestern Oregon: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 504.

From this table it appears that Kachemak Bay coal has a high percentage of moisture and volatile combustible matter, a moderate amount of ash, and remarkably little sulphur. Judging from the chemical analyses its fuel value is lower than that of Port Graham coal, and both are low in comparison with that of the Vancouver Island and Bering River coals.

TESTS AND CONCLUSIONS.

Aside from chemical analyses and theoretical conclusions regarding the value of Kachemak Bay coal some data have been collected from experiments in its use. Dall obtained some information in regard to tests made with it, and the following is quoted from his report:[a]

[a] Dall, op. cit., pp. 830-832.

During part of the expedition of twenty-eight days' cruising on the steam tug *Kodat*, in July and August, 1895, we were obliged to burn coal from the Bradley seam, Kachemak Bay, Cook Inlet, which was dug out of the beach at low water with crowbars and burned as it was, covered more or less with barnacles and seaweed. This coal, being under water most of the time, must have had a larger percentage of moisture than the normal amount belonging to it. The opinion of the engineer of the *Kodat* was to the effect that this lignite did from 60 to 75 per cent of the duty of Wellington (B. C.) coal.

Several hundred tons of coal from Eastland Canyon, Kachemak Bay, were imported into San Francisco by the Alaska Mining and Transportation Company in 1895, and distributed to various manufacturing establishments for trial. Among these was the foundry of Messrs. W. T. Garrat & Co., well known as the principal brass founders of the Pacific coast. I was informed by their manager that this coal, to the amount of 50 tons, had been in use for making steam in their establishment, and was regarded by them as a very fair steaming coal. When a good fire was kept up they used 2,600 pounds in a given time, during which they would have used 2,200 pounds of Comox (B. C.) coal. With a low fire and small pressure of steam the amount used was 2,240 pounds to 1,350 of Comox. They stated that if the Cook Inlet coal could be furnished at a price corresponding to its relative efficiency compared with the British Columbia coal they should be glad to make regular use of it.

By permission of the Secretary of the Navy, and at the request of some New York parties, Lieut. R. P. Schwerin, in April, 1891, proceeded to Cook Inlet to examine the coal fields. The party was provided with a diamond drill and examined numerous seams. From four localities in particular, one of which was McNeil Canyon, Kachemak Bay, 50 tons of coal each were mined and brought to San Francisco. Lieutenant Schwerin informed me that during the entire summer this coal was used under the boiler and for cooking in camp and aboard ship. It gave very satisfactory results for stationary purposes, though the coal slacks into chiplike fragments rather rapidly after exposure to a dry atmosphere. He induced the Southern Pacific Company of California to make a test of the coal on their locomotives, a purpose for which it proved unfit owing to its sparking tendency, which, under forced draft, was very pronounced in spite of the use of fine netting over the stacks. There was no trouble of this kind when used under stationary engines or in a cooking stove.

The following summary of the data of the test, prepared September 29, 1891, was kindly furnished to Dr. Becker by Lieutenant Schwerin, who is now one of the staff of the Southern Pacific Railway organization. The kinds of coal with which the Cook Inlet lignite was compared were the ordinary Nanaimo coal from Vancouver Island and bituminous Cardiff coal imported as ballast by wheat ships.

Comparative tests of Cook Inlet, Nanaimo, and Cardiff coals.

	Cook Inlet.	Nanaimo.	Cardiff.
Number of trips	2	2	4
Average number of miles per trip	86	168	86
Average gallons water used per trip	3,734	13,836	2,989
Average pounds fuel per trip	6,982	18,551	3,601
Average number loaded cars per trip	6.2	11.98	6
Average number empty cars per trip	....	1.401	75
Average tons weight loaded cars per trip	155.35	....	139
Average tons weight empty cars per trip	....	....	21.25
Average tons weight train without the engine and tender	155.35	301.47	160.25
Gallons water used per ton of train	24.04	45.895	18.653
Pounds fuel used per ton of train	44.94	61.535	22.473
Water evaporated per pound of fuel	4.46	6.215	6.917
Fuel burned per gallon of water evaporated	1.87	....	1.205
Average steam pressure, pounds	130.5	143	150.3
Average temperature of air, degrees	....	....	52
Average temperature of feed water, degrees	68	....	57
Average temperature of steam, degrees	355.6	....	365.7
Area of grate, in square feet	16.87	25.6	16.87
Average fuel per hour per square foot of grate, pounds	....	....	54.215
Total heating surface	1,325	1,288	1,325
Pounds fuel burned per hour per square foot of heating surface	....	....	.69
Pounds fuel burned per ton per mile	.5226	.3663	.2613
Equivalent evaporation from temperature of feed water	5.33	7.507	8.369
Average number of miles run per ton fuel burned	24.635	18.112	47.762
Per cent value of fuel from evaporation	63.678	89.7	100

It thus appears that the Cook Inlet coal, under these conditions, has 71 per cent of the heating effect of Nanaimo coal and 63.7 per cent of Cardiff bituminous, a result which agrees fairly well with that derived from the other tests above mentioned.

The following table, adapted from Goodyear,[a] shows the relative value as fuel of the Pacific coast lignites, to which I have added the Cook Inlet variety:

Table of relative values of Pacific coast lignites.

Locality.	Value.
Mount Diablo, Black Diamond (best)	1.000
Bellingham Bay, Washington	1.148
Seattle, Wash., average of 3 tests	1.229
Nanaimo, British Columbia (2 tests)	1.306
Wellington, British Columbia (2 tests)	1.351
Cook Inlet, average of 4 tests	.927

A series of tests made on the steamer *Dora*, which at present plies between Valdez and Dutch Harbor, is reported by James D. Garvey, chief engineer, in the following letter to Alfred Ray:

I received some of your Homer coal July 21 [1899], and as it gave good results I thought I would make a test and compare it with other brands of coal we have been using on this ship. The tests were made under the following conditions, viz, consumed in Scotch marine boiler with straight double grate bar, natural draft, and fair steaming weather.

Wellington: 5¼ tons per 24-hour day (2,000 pounds per ton); ashes, 1,170 pounds, mostly heavy clinker; 10.6 per cent waste; good steam coal; black smoke.

Seattle Franklin coal: Very dirty; can not get steam over 100 pounds for any length of time; thick black smoke; 6¼ tons per day (2,000 pounds per ton); ashes, 2,250 pounds, like black sand; 10.57 per cent waste.

Newcastle, N. S. W.: 5 tons per day (2,000 pounds per ton); ashes, 768 pounds, with little clinker, very thin; 7.68 per cent waste; light-gray smoke (good coal).

Tyonok, Cook Inlet lignite: 9 tons per day (2,000 pounds per ton); ashes, 1,300 pounds, with little clinker; 7.22 per cent waste; a little gray smoke; makes steam easy, but very smoky smell.

Homer fuel: 4 tons 14 hours running time (2,000 pounds per ton); ashes, 420 pounds (equivalent to 6¾ tons 24-hour day and 720 pounds ashes); a pure fine white ash; 5.25 per cent waste, makes a very hot and lasting fire, no smoke, and no trouble to make all the steam we want, and to clean fire only use poker the same as in house grate, and I can truthfully recommend it to large steam plants as a good, clean, and lasting fuel.

The experience of the writer, who was at Homer three weeks, is that the general run of Kachemak Bay coal is excellent for use in heating and cooking stoves. It is clean to handle, ignites easily, makes a hot fire, does not soot the bottom of cooking utensils, makes very little smoke, and leaves only a moderate amount of ash. It slacks on exposure, but this does not seriously affect its fuel value. In drying it loses its brilliancy and takes on a dull, shaly appearance, in which condition doubtless many would scorn it as an unpromising fuel. The loss of moisture may not be to its disadvantage, but still there was no perceptible difference in heating qualities between coal which had been under shelter for two years and that which was washed up on the beach at Homer after migrating several miles in the longshore currents.

Other things than the quality of the fuel itself must be considered in discussing the economic value of a coal deposit. Among these are the undisturbed or broken condition of the strata as a whole, the thickness of the seams, the character of roof and floor, the accessibility of a supply of good lumber for timbering, the ease or difficulty of getting the fuel to market, the availability of mining labor, and the demand for the fuel.

The coal strata just west of Coal Point outcrop in a bluff above the sea beach, dip inland at a low angle, and so far as observed are evenly bedded and undisturbed

[a] Goodyear, W. A., Coal Mines of Western Coast of United States, 1877, p. 164.

by flexures or faults. Several of the seams are thick enough for economic mining. Unfortunately the roof rock is generally weak, which would necessitate timbering. The floor is often clayey and probably would have a tendency to swell. There is sufficient and suitable timber close at hand for all mining purposes. An excellent harbor, open at all seasons of the year, is reached by a light railroad, extending from the mine to deep water, at the outer end of the spit. The region is subject to severe storms during the spring and fall.

FUTURE PROSPECTS.

There is no available local labor, and any that might be imported would possibly be affected by a rush for a new gold field. It seems probable that the natural demand for this coal under present conditions can not be large. Its quality is fairly good for steaming purposes and household use, but the steamers which might make use of it are not fitted with grates fine enough to burn this coal without a considerable loss into the ash pit. There are at present no stationary engines requiring such fuel in the region, and the population for hundreds of miles is extremely scanty, mostly penniless natives, and, therefore, the demand for household uses is almost nil. If the Kachemak Bay lignite could be mined in large quantities by economical methods and placed on the market in the Pacific coast towns at a price commensurate with its relative efficiency, compared with the coal now being supplied to those markets, it might compete. But it is doubtful if it can be supplied at such a price.

SUMMARY.

In the foregoing pages a history of coal mining in the Kachemak Bay region has been given, and the Kenai formation, which occurs on the shores of Kachemak Bay and Port Graham, has been described. The Kenai formation contains a large number of lignite beds, and their occurrence has been described in detail. Four sections of the formation, having an aggregate thickness of 1,765 feet, and 10 detailed sections of the thicker coal seams are given. Proximate analyses showing the character of the coal in different seams in this locality are compared with analyses of other Pacific coast coals. It is shown that the lignite at Port Graham is probably of a slightly higher grade than that on the north shore of Kachemak Bay, but that the Port Graham field is very limited and lies largely below sea level. Although the Kachemak Bay lignites constitute an extensive field and occur in beds ranging up to 7 feet in thickness, their average fuel ratio is only 0.76. In comparison with Vancouver Island bituminous coals, having an average fuel ratio of 1.88, and with semibituminous coals from Bering River, Controller Bay, whose ratio is 5.82, the lignites here described can at present create no great demand for their use.

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[Bulletin No. 277.]

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Topographic Maps of Alaska.

The following maps are for sale at 5 cents a copy, or $3 per hundred:

Fortymile quandrangle; scale, 1:250000. E. C. Barnard.

Grand Central Special, Seward Peninsula; scale, 1:62500. T. G. Gerdine.

Juneau Special quadrangle; scale, 1:62500. W. J. Peters.

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The following maps are included as illustrations of published reports, but have not been issued separately. They can be obtained only by securing the report.

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Chitina and lower Copper River region; scale, 1:250000. Contained in a special publication of the United States Geological Survey, entitled "The geology and mineral resources of a portion of the Copper River district, Alaska." Washington. Government Printing Office, 1901. T. G. Gerdine and D. C. Witherspoon.

Cook Inlet, head of, to the Tanana via Matanuska and Delta rivers, also part of Kenai Peninsula; scale, 1:625000. Contained in "A reconnaissance from Resurrection Bay to Tanana River, Alaska, in 1898." Twentieth Ann. Rept., pt. 7, 1900, pp. 265–340. W. C. Mendenhall.

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Copper River region; scale 1:376000. Contained in [illegible]

Bulletin No. 278

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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGY AND COAL RESOURCES OF THE CAPE LISBURNE REGION, ALASKA

BY

ARTHUR J. COLLIER

WASHINGTON

GOVERNMENT PRINTING OFFICE

1906

CONTENTS.

ILLUSTRATIONS.

GEOLOGY AND COAL RESOURCES OF THE CAPE LISBURNE REGION, ALASKA.[a]

By Arthur J. Collier.

INTRODUCTION.

Cape Lisburne is the bold headland which marks the northwestern extremity of a land mass projecting into the Arctic Ocean from the western coast of Alaska between latitudes 68° and 69°. It lies 160 miles north of the Arctic Circle, 300 miles directly north of Nome, and is the only point in Alaska north of Bering Strait where hills above 1,000 feet in height approach the sea. This peninsula can be conveniently termed the Cape Lisburne region. Its general position is shown in Pl. I. In outline it roughly resembles a conventional hand, of which Cape Lisburne forms the knuckle and Point Hope, about 40 miles southwest of Cape Lisburne, the index finger, pointing west.

The only mineral resources of the region that are known to be of commercial importance are the coal deposits, which are the subject of this report, though gold is reported on the headwaters of some of the rivers.

The coal fields are accessible only by sea, and in this way only from July to October, inclusive. There are no harbors or protection for seagoing vessels, but in calm weather, or when the winds are from the south, coal can be boated or lightered to ships anchored from 1 to 2 miles offshore.

The nearest protected harbor is Kotzebue Sound, about 200 miles southeast, near which there are several placer gold-mining districts of considerable importance. The whole region is exceedingly bleak and dreary. It is far beyond the northern limit of spruce timber and even the willows are stunted, the largest in the most sheltered places being not over 4 feet high. The nearest standing timber suitable for mining purposes is at the mouth of the Noatak, 150 miles southeast.

On account of the economic importance of the coal deposits and the scientific interest in the geologic formations known to exist there, a somewhat detailed examination of the field was undertaken by the United States Geological Survey in 1904, and to this work the writer was assigned. The important economic result of this expedition is the demonstration (1) that the coal fields are much more extensive than has generally been supposed, and (2) that there are two distinct coal-bearing formations in the region. One lies east of Cape Lisburne and contains low-grade bituminous coal of Jurassic age, the other lies south of the cape and includes high-grade bituminous coal of lower Carboniferous age.

[a] An abstract of this report has already appeared in the report on progress of investigations of mineral resources of Alaska in 1904, Bull. U. S. Geol. Survey No. 259, 1905, pp. 172-185.

HISTORY AND EXPLORATIONS.

Captain Cook[a] discovered and named Cape Lisburne in the year 1778, but coal was first reported in the region by Mr. A. Collie,[b] who accompanied Captain Beechey to the Arctic Ocean in 1826 and 1827. The point of discovery by Mr. Collie was near Cape Beaufort, a minor headland of the coast line, 70 miles east of Cape Lisburne. Belcher and Collie of the Beechey expedition also collected paleontologic materials and made notes on the geology at Cape Lisburne and Cape Thompson.[c]

Kupreanoff and Fisher collected fossils at Cape Thompson and Cape Lisburne, and these were examined and reported on by Grewingk[d] in 1848 and 1849.

During the last twenty-five years whalemen have often replenished their fuel supplies from these coal beds. The points most frequently visited were Corwin Bluff, 28 miles east of Cape Lisburne, where the United States revenue cutter *Corwin*, Captain Hooper commanding, coaled in 1881,[e] and the Thetis mine, 36 miles east of Cape Lisburne, where the United States revenue cutter *Thetis* coaled in 1888 and 1889,[f] though both localities were probably visited by whalemen previous to either of the above dates.

Henry D. Woolfe[g] and J. W. Kelly in the employ of the Pacific Steam-Whaling Company built a house and wintered at Corwin Bluff in 1884 or 1885, but their attempts to operate coal mines met with little success. Paleobotanic collections from the coal-bearing formation and geologic notes were, however, made by Woolfe[h] and some exploration of the interior was done by Kelly.[i]

Lieutenant Jarvis[j] on the overland relief expedition to Point Barrow camped at the Corwin coal mine March 9, 1898, but found only a part of the Woolfe and Kelly house standing, most of it having been torn down for firewood by travelers en route to or from Point Barrow.

The discovery of gold at Nome in 1898 drew attention to these deposits as possible sources of fuel supply for the mines of Seward Peninsula, and several companies were organized to exploit them. Large areas of coal land were staked and several cargoes of coal, probably over 1,000 tons in all, were mined and sold at Nome in 1900 and 1901, but since then the production has been merely nominal.

Schrader,[k] of the United States Geological Survey, visited Corwin Bluff in 1901 at the end of his field season in northern Alaska, and collected notes on the geology of the region from various prospectors.

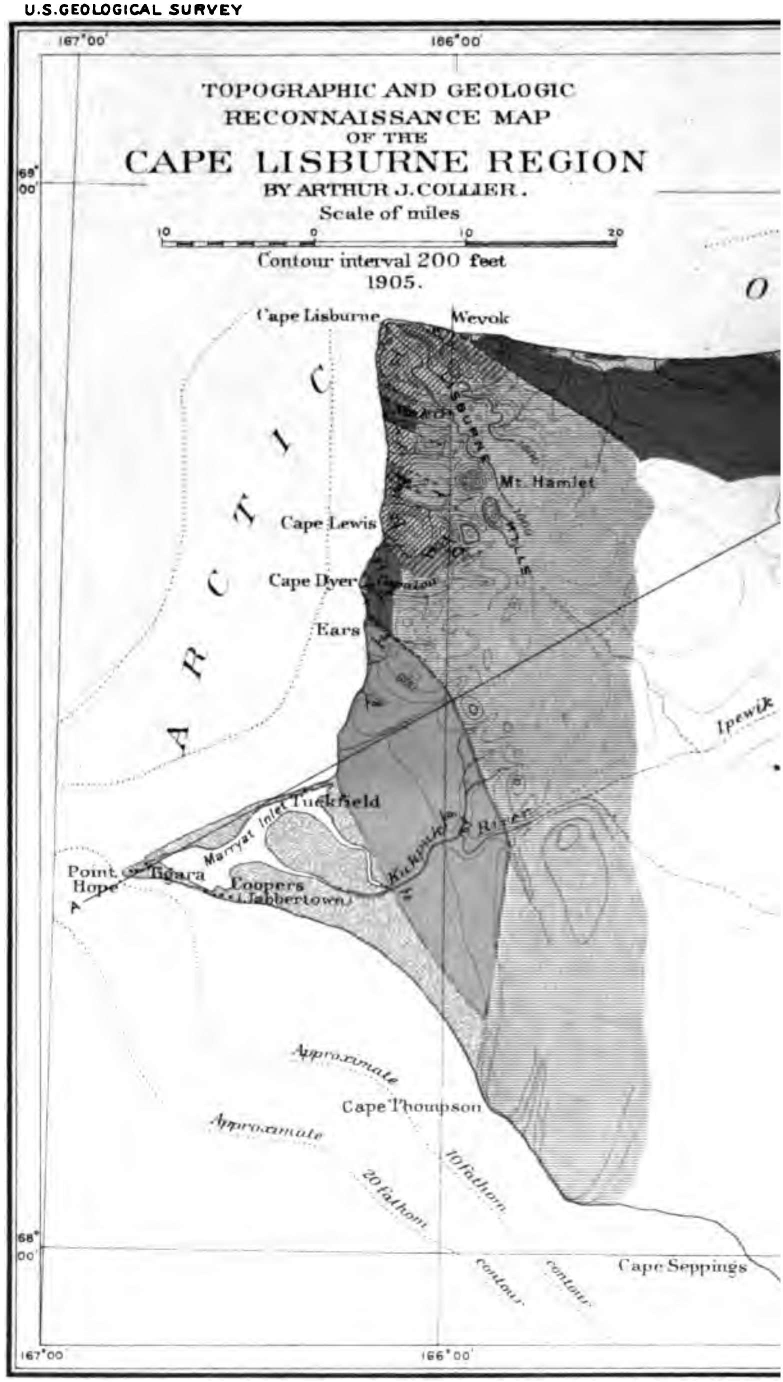
A more detailed examination of the region, made by the writer in 1904, gave the information contained in the present bulletin.

ITINERARY.

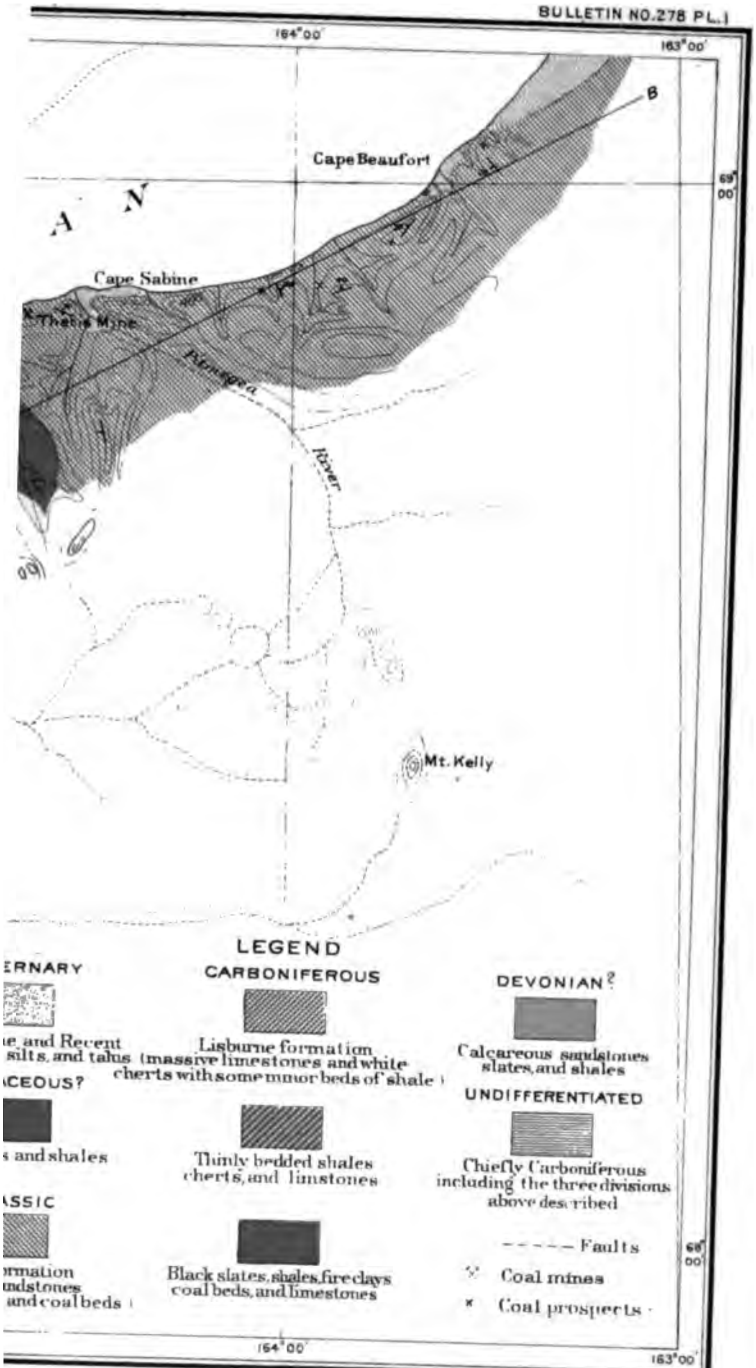
Under instructions from Alfred H. Brooks, geologist in charge, the writer, accompanied by Chester Washburne as field assistant, sailed on June 25, 1904, from Seattle and arrived July 4 at Nome, where final preparations were made. A boatman, Joseph Edge, was employed, and a large well-constructed dory of the type used by surfmen at Nome was purchased for the transportation of the party along the coasts of the Cape

[a] Cook, James, Voyage to the Pacific Ocean. London, Hughs, vol. 2, 1785, p. 460.
[b] Buckland, W., Geology and Zoology of Captain Beechey's Voyage. London, Henry G. Bohn, 1839, p. 173.
[c] Buckland, op. cit., pp. 171-174.
[d] Grewingk, C., Beitrag zur Kentniss der orographischen und geognostischen Beschaffenheit der Nord-West-Küste Amerikas mit den anliegenden Inseln: Verhandl. Russ.-K. Mineral. Gesell. zu St. Petersburg, 1848, 1849.
[e] Hooper, Capt. C. L., Report of the cruise of the United States revenue steamer *Thomas Corwin* in the Arctic Ocean, 1881, 48th Cong., S. Ex. Doc. No. 204, pp. 49-50.
[f] Stockton, Charles H., Arctic cruise of the U. S. S. *Thetis* in 1889: Nat. Geog. Mag., vol. 2, p. 178.
[g] Geographic notes: Science, vol. 6, 1885, p. 381.
[h] Woolfe, Henry D., Arctic district of Alaska, population and resources: Eleventh Census, 1890, pp. 132-133.
[i] Stockton, Charles H., Cruise of the U. S. S. *Thetis* in 1889: Nat. Geog. Mag., vol. 2, pp. 178-180.
[j] Jarvis, D. H., Report of the cruise of the U. S. revenue cutter *Bear* and the Overland Relief Expedition: Treas. Dept. Doc. No. 2101, 1899, p. 71.
[k] Schrader, F. C., A reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, pp. 109-114.

U.S. GEOLOGICAL SURVEY



HYPOTHETICAL GENERALIZED



TION ALONG LINE A-B.

Lisburne region. The steamship *Corwin*, which was on a regular run between Nome and Cape Blossom, was chartered to transport the party to the Corwin mine, which is about one and one-half days' steaming beyond Cape Blossom. On account of the bad weather in the early part of July the party waited till the 17th to embark. During the next few days the weather was perfect as the ship sailed leisurely northward, stopping at various points along the coast to put off passengers or freight. Stops of an entire day in each case were made at Teller, Deering, and Kiwalik. While the ship lay at Teller, C. J. Hutchinson joined the party as a volunteer field assistant and rendered valuable service throughout the season. The ice pack had now already retreated northward and the shores were green with vegetation. The atmosphere was filled with strange mirages making the low shores of Seward Peninsula loom up like fantastic dumb-bell-shaped mountains. It is said that under these atmospheric conditions a whaling ship 40 or 50 miles away can often be seen sailing bottom side up on the lower edge of a cloudy sea. Every night the sun dipped below the northern horizon merely long enough to show the sunset colors and then came up to begin the circuit of another day. Nor was the scene devoid of human interest, for frequently an overloaded "umiak," the carryall of an Eskimo family, would pull out from shore and ask a tow to the next village, or a solitary prospector in a dory or Peterboro canoe would row out to mail a letter and inquire the news. At Point Hope the ship was surrounded by a swarm of small craft loaded to the guards with Eskimo men, women, and children, who came on board to trade furs and ivory trinkets for calico, tobacco, and chewing gum. Here Mr. E. J. Knapp, an Episcopal missionary, who had been a very agreeable companion on the voyage, went ashore to remain throughout the winter, the only white man in the village of Tigara. When we sailed from this place, the members of the Geological Survey party were the only passengers on board.

On the morning of July 23 we rounded Cape Lisburne and were landed with equipment and supplies at Corwin Bluff. Camp was pitched at the mouth of a small creek east of the bluff, near the house of an Eskimo, who presented a paper which stated that his name was Cullinghow and that he had been placed by the president of the Arctic Development Company in charge of the property. Two days later Joseph Tuckfield and John Hackman with a party of natives from Point Hope arrived at the mine and began to get out a supply of coal for use at the whaling station during the winter. They camped in a house built by the Corwin Trading Company 1 mile west of Corwin Bluff.

There was at this time no snow on the level ground, but along the shores the cliff faces were covered by the remnants of great snowdrifts accumulated the winter before, which had been undermined by the surf so that they presented ice cliffs often 75 to 100 feet high in front of the real cliff face (see Pl. II, *B*). This condition interfered seriously with the work of the geologist, not only because the exposures were covered up, but also on account of the danger from falling stones along the foot of the cliffs while the ice melted. For a few days the weather was quite warm and mosquitoes were troublesome, but it soon became cold and stormy with almost continuous winds either from the south or northeast.

On July 26 most of the supplies were left in charge of Cullinghow while the party, with a light outfit, moved eastward along the coast toward Cape Beaufort. Camp was pitched that night at the mouth of Thetis Creek, 6 miles east of Corwin Bluff. Next day the weather became stormy, with a northeast wind and a heavy surf, and the party was stormbound for three days, during which time a somewhat detailed examination was made of the coast between Thetis Creek and Pitmegea River and of the drainage basin of Thetis Creek.

On the evening of July 29 the surf went down and a southwest wind came up. Camp was broken about 6 p. m. and the party put to sea, sailing while the wind lasted and rowing after it died down, and reached a point about 10 miles east of Cape

Sabine, where a safe landing was made at 1 a. m., in spite of a heavy fog which settled down about midnight and made it almost impossible to see the shore.

On July 31 the attempt to continue the journey toward Cape Beaufort resulted only in filling the boat with water and covering a distance of about 1 mile, when owing to a heavy sea and head wind it was necessary to land and pitch camp. On account of the many delays, provisions were running short and it was evident that the party must soon return to the base of supplies, so at 3 p. m. the writer started on foot along the beach to Cape Beaufort, about 15 miles distant, where he arrived about midnight. This is the most northern point reached during the season. The cape is not marked by any angle in the coast line, but by a hill 500 feet high, one-fourth of a mile back from the coast, whose slopes terminate along the coast in a bluff about 50 feet high with a narrow beach below. As the sun went down a heavy fog settled over Cape Beaufort and the writer made a hasty examination of the rocks exposed, collected a load of fossil plant specimens, and started back to camp within two hours of the time of his arrival.

On the evening of August 1 the boat loaded with camp outfit was successfully launched in spite of a somewhat heavy surf and sailed with a fair wind back to Corwin Bluff, arriving there about 1 a. m. August 2. A heavy surf was running, and in landing the boat filled so that it was due only to good fortune and seamanship that a serious accident was averted. Though most of the outfit was wet, nothing was irreparably injured except one of the cameras, which was practically ruined. The collection of fossil plants which had been made was packed up ready for shipment to Point Hope and delivered to Tuckfield and Hackman, who, with their party of Eskimos, were still at the mine stormbound. During the next few days the weather continued too stormy to permit moving camp along the coast. The northeast wind, which had blown steadily for nearly a week, was succeeded by a southerly gale, which though it laid the surf made a new danger, that of being blown out to sea. While stormbound here some further collections of fossils were made and the topographic mapping was extended several miles southward.

On August 6 the storm abated in the evening and camp was broken at 4 p. m. Since there was no wind, progress was made with oars and by towing along the beach for about 25 miles to Wevok, a native village about 3 miles from Cape Lisburne, where camp was again pitched at 7 a. m. August 7. Cape Lisburne is a famous wind hole and can be passed safely in a small boat only during fair weather. Within the next two days stormy weather began again and the party was detained at this place for a week. Even geologic work on land was done with great difficulty on account of the high wind. A party of two Eskimos and two white men from Point Hope, who were gathering driftwood south of Cape Lisburne, ventured offshore in a whaleboat and were blown out to sea and lost.

The morning of August 13 was fair and the outfit was successfully launched for a sail around the cape, just as the United States revenue cutter *Thetis* returning from her cruise to Point Barrow hove in sight. Picking the party up, she landed them safely at Cape Lewis, about 10 miles south of Cape Lisburne, where the coal beds of the Carboniferous series were examined.

On August 16 camp was moved to the entrance to Marryat Inlet, and next day to the whaling station on the south side of Point Hope. Leaving the camp here, the writer returned to the north side of the point and ascended the Kukpuk River, which flows into Marryat Inlet.

The whole party sailed from Point Hope on the United States revenue cutter *Thetis* on August 22, and were landed at Cape Prince of Wales August 23 to make an investigation of the developments made during the season in the tin deposits of the York region. During the field work Mr. Washburne was mainly employed in collecting fossils, while the writer, assisted by Mr. Hutchinson, was more especially occu-

A. U. S. REVENUE CUTTER THETIS IN THE EDGE OF AN ICE FLOE.

Showing difficulties of navigation in the early season in the Arctic Ocean and Bering Sea.

B CLIFFS WEST OF CORWIN BLUFF.

Corwin mines are in the foreground.

pied in the preparation of a topographic map, the examination of the coal beds, and the investigation of the more general stratigraphic relations.

On August 27, at the mouth of Lost River, the *Thetis* again took the party on board and after a cruise in Bering Sea, in the course of which landings were made on St. Lawrence, St. Matthew, and Unalaska islands and on the Siberian coast, points seldom visited by geologists, we arrived at Port Townsend on September 30.

ACKNOWLEDGMENTS.

The writer wishes to express his appreciation of the services of the other members of his party, Messrs. Washburne, Hutchinson, and Edge, all of whom were faithful and untiring in spite of many discomforts and hardships, and contributed much to the fund of information obtained.

Similar acknowledgments are due to Captain Hamlet and the officers of the United States revenue cutter *Thetis*, who brought the party from Point Hope to Seattle, and who furnished every convenience possible for our investigations.

Special thanks are due to the following residents of the Cape Lisburne region, whose hospitality and courtesy were unbounded: Joseph Tuckfield and John Hackman at considerable inconvenience transferred several hundred pounds of rock specimens from the Corwin mine to Point Hope and looked after their shipment. They also furnished the writer with a map of the interior compiled from the explorations of a number of natives. Later Mr. Tuckfield accompanied the writer on his trip up Kukpuk River. Mr. H. Koenig, commonly known as "Cooper," furnished an almost continuous meteorologic record, taken at the whaling station for five years. And finally Cullinghow, the Eskimo watchman at the Corwin mines, faithfully looked after our stores and camp while we were on the trip to Cape Beaufort and also furnished useful information and a map showing the drainage and routes of travel in the interior portion of the region.

Acknowledgments are also due to the paleontologists, paleobotanists, and chemists, without whose reports on the materials collected this bulletin would lose much of its scientific value. David White examined and reported on the Paleozoic plants; G. H. Girty examined the large collection of Paleozoic invertebrates, and F. H. Knowlton examined the large collection of Mesozoic plants from the Corwin formation. The samples of coal collected by the party from various beds of both the Corwin and Lisburne formations were assayed by W. T. Schaller in the Survey laboratories.

GEOGRAPHY.

The Cape Lisburne region, as discussed in this paper, comprises the northernmost of the four great land masses which project from the western coast of Alaska. Its general position and the details of coast-line settlements, drainage, and topography appear on the reconnaissance map, Pl. I., which is based on Beechey's chart, the field notes of the writer, and information obtained from prospectors and natives who have penetrated the interior beyond the limit of this expedition. No accurate topographic surveys have been made.

COAST LINE.

A reference to these maps will show that Point Hope, which is called "Tigara" (the index finger) by the natives, is the most western point in the region. Southeast of Point Hope the coast is made up of long concave stretches of beach between minor promontories and extends in an approximately straight line for 180 miles to Kotzebue Sound. The southern point of the area under discussion is Cape Thompson, which is about 35 miles southeast of Point Hope. This cape is formed by a series of sea cliffs about 500 feet high, extending in a southeast direction for about 6 miles, and a concave beach line extending northwestward from it to Point Hope. At Point Hope the coast line makes an acute angle and extends eastward in a slightly

convex line of beaches for 16 miles, where it turns northward forming a reentrant angle. From this point to Cape Lisburne, a distance of about 30 miles, the coast line is marked by a series of cliffs, usually with narrow beaches before them, forming an approximately straight line. At Cape Lisburne the coast line makes a second acute angle and extends east for about 28 miles to Corwin Bluff. It then gradually curves northward to Point Lay, 100 miles from Cape Lisburne and beyond the limit of this investigation. The Cape Lisburne cliffs extend east from the cape for about 2 miles where a line of beaches begins, which is almost continuous to Point Barrow. In many places narrow lagoons occur back of these beaches. They increase in size toward the northeast, and the largest ones are outside of the province of this report.

Wherever cliffs occur along this part of the coast they are usually less than 200 feet high and have narrow beaches below them, and if it were not for the snowdrifts, which in many instances remain all summer, it would be possible in calm weather to traverse the beach nearly all the way from Cape Lisburne to Point Lay. Along this part of the coast there are few prominent features. The ones worthy of mention are Corwin Bluff, Cape Sabine, and Cape Beaufort. Corwin Bluff, 28 miles east of Cape Lisburne, is a headland 200 feet high, projecting only slightly beyond the regular coast line and interrupting the continuity of the beach for only a few hundred yards. (See Pl. II, *B*.) Cape Sabine, about 40 miles east of Cape Lisburne, is a low point, not well defined, projecting possibly one-fourth of a mile into the sea. Cape Beaufort, about 70 miles from Cape Lisburne, is not marked by any bend in the shore line, and the name is applied to a hill about 500 feet high, one-fourth of a mile back from the shore.

The region contains no harbor suitable for vessels drawing more than 10 feet. The nearest harbor for such vessels is Kotzebue Sound. Marryat Inlet at Point Hope is a good harbor for vessels drawing 10 feet or less. The entrance is on the north side of the point, and is difficult in rough weather on account of a shoal extending some distance offshore. [a]

THE ARCTIC OCEAN.

The adjacent parts of the Arctic Ocean are generally shallow, probably nowhere exceeding 35 fathoms in depth. West of Point Hope 13 fathoms is carried within one-fourth mile of the beach, but north of Point Hope a depth of only 5 fathoms is found half a mile from shore. In the bight north of Cape Lisburne the water is shallow but the bottom is regular and good anchorage can be had from 1 to 2 miles offshore.

The following paragraphs on the distribution of ice packs and currents in the Arctic Ocean are taken almost verbatim from the bulletin by Lieutenant Jarvis: [b]

> During the winter months the ocean as far north as Cape Prince of Wales is covered by an impenetrable ice pack, which rises in irregular masses 10 to 25 feet above the water. Though the pack contains no real icebergs it nevertheless extends 6 to 8 fathoms below the water and occupies from a third to a half the depth of the shallow Arctic Sea. Few ships have been built that will stand its crushing force, and no ram ever constructed is powerful enough to break its way through it.
>
> The southern limit of the ice is determined almost entirely by the direction and force of the winter winds, since it is in part the product of each winter's freezing and in part the accumulation of many winters driven down from the north.
>
> It is reported that heavy southerly winds and swells break up the ice, and if these are followed by northerly winds it spreads out and offers navigable channels. Northeast winds tend to drive the ice off the American shore, and westerly winds off the Siberian shore. Bering Strait is usually open by the first week in July and sometimes earlier, but clear water does not extend far northward, and it is seldom possible for ordinary vessels to reach Point Hope before July 10 or 15. By July 15 the main pack has usually moved north of Cape Lisburne, but thinner "running ice" from Kotzebue Sound is usually encountered at Point Hope sometime after the pack has moved north. Thus far the move-

[a] Jarvis, D. H., Coast Pilot Notes on the Fox Islands passes, Unalaska Bay, Bering Sea, and Arctic Ocean as far as Point Barrow. Bull. U. S. Coast and Geodetic Survey No. 40, 2d edition, 1900, p. 56.
[b] Jarvis, D. H., Bull. U. S. Coast and Geodetic Survey No. 40, 2d edition, 1900, pp. 49–52.

ments of the ice do not appear to depend to any great extent on the winds and they are reasonably certain each year.

When the ice pack moves off the coast in the early summer it leaves a strip of quiet water between it and the shore, which can be taken advantage of instead of harbors by ships lightering coal and other materials from the land. Later in the season when the ice has moved farther out to sea there is no protection for vessels. The difficulties of navigation early in the season are shown in the photograph, Pl. II, *A*.

From Bering Strait to Point Barrow there is a general current in the ocean setting northward along the shore, which, when not affected by the winds or stopped by the ice, has an average velocity of not less than 1 knot per hour. At Point Hope its velocity is from 1½ to 2 knots, but north of Cape Lisburne it does not exceed 1 knot.

In the bight north of Point Hope there is probably an eddy which causes a local current to the west along the north shore of the point. In the bight north of Cape Lisburne there is said to be a tidal current, and unless driven in by westerly winds the outside general current is not felt.

CLIMATE.

Records of temperature have been kept at Point Hope almost continuously for the last sixteen years. The lowest temperature recorded is −48° Fahrenheit in February, 1892. The highest temperature recorded was 97° in July, 1891. During the year 1904 the lowest temperature was −12° in February, and the highest 67° in July.[a]

The coldest days are apt to be calm, but fierce blizzards from the northeast are of frequent occurrence and the temperature during the winter rarely rises above zero. The average temperature recorded while the party was in the field last summer was 48°. During the summer the winds blow alternately from the south and the northeast, periods of calm intervening. In the month between July 22 and August 22, 1904, while the Geological Survey party were in the Cape Lisburne region there were not more than ten calm days. The heaviest summer storms come from the southwest. These occur only occasionally, sometimes at intervals of years, and are short-lived but very severe and disastrous, as there is little protection from the wind in that quarter.[b]

Though no such storm occurred during the season of 1904, evidences of storms were observed, such as driftwood piled high above the usual reach of the tide at the east ends of the lagoons.

LIFE.

Vegetation consists only of very hardy plants, most of which reach their maturity in the short season. Willows not over 4 feet in height grow in sheltered places along some of the water courses. These are the largest plants the region can produce and are usually not large enough for firewood. Grasses and some flowering plants are to be found almost everywhere, though with very few exceptions these are too scanty to afford forage for horses. Mosses and lichens are also abundant, but no extensive patches of reindeer moss were seen.

Caribou are still seen occasionally, but are very rare. Mountain sheep formerly abundant in the region were reported as late as 1881, but are now probably extinct.[c] White foxes and polar bears are abundant and their skins are a source of revenue to the natives.

Among birds ptarmigan can be found in many places on land, while along the seashores and the rivers and ponds of the interior geese and ducks are very abundant during the summer. The most prized are probably the eider ducks, which fly south along the coast in great numbers in the fall. The cliffs at Cape Lisburne and Cape Thompson are famous nesting places and are frequented by myriads of sea fowls, including gulls, sea parrots, and murres. Great numbers of eggs are gathered here each year by the natives. The cries of the birds, which can be heard for several miles, serve as warning signals to passing ships during foggy

[a] Communicated to the writer by H. Koenig.
[b] Jarvis, D. H., Bull. U. S. Coast and Geodetic Survey No. 40, 2d edition, 1900, p. 52.
[c] Hooper, Capt. C. L., Cruise of the *Corwin* in 1881. 48th Cong. S. Ex. Doc. No 204, p. 50.

weather. In the bight north of Cape Lisburne thousands of broods of young ducks congregate while their feathers are growing, and in years past have afforded good sport as well as an abundance of fresh meat to the crews of the whaling fleet.

SETTLEMENTS.

The location of settlements and villages in this region is determined by the proximity of hunting and fishing grounds. Formerly there were villages along the rivers of the interior, but since the caribou and sheep have disappeared the settlements are confined to those points along the coast where fish, seals, walrus, and whales can be killed or where the bird rookeries are accessible.

The principal settlements are located on the Point Hope peninsula, which projects far out into the ocean and forms an ideal base for sealing and whaling operations. It is also in close proximity to the largest river of the region, where an abundance of salmon can be obtained and where in the fall of the year great flocks of geese and ducks congregate in their migration from points farther north. The settlements here consist of a native village[a] called "Tigara," at Point Hope, and of a number of whaling stations maintained by white men distributed for 6 or 7 miles along the south side of the peninsula.

At the breaking of winter leads of open water form in the ice pack often several miles from land and the whalemen move out to the edges of the shore ice and camp there through the whaling season, which lasts about a month. When a whale is sighted it is attacked from the ice if the lead is narrow, or from canoes and boats if the lead is wide. Native skin canoes are preferable for this purpose, since they are light and can easily be sledded over the ice. Ivory-pointed harpoons with detachable shafts and sealskin lines attached to floats made of whole sealskins sewed up and inflated with air are used to prevent the escape of the whale, and as soon as possible it is killed by an explosive projectile from a bomb gun. This weapon, which has a caliber of about 1 inch, may be fired from the shoulder or may be mounted in the bow of the attacking boat. When killed the whale is towed to the edge of the ice and, if possible, hauled out of the water with tackles. The whalebone belongs to the hunters and is chopped out with axes, but the meat belongs to the entire village. The natives swarm around the carcass with axes and spades, each family striving to get as much of the meat as possible. Almost every part is saved and stored in underground houses, where it is kept frozen until used. The whaling stations kept by white men usually employ a number of natives, and on account of the high price received for whalebone the business is profitable, even if not more than one or two whales are killed during the season.

The center for this whaling industry is about 6 miles east of Tigara village and is locally called "Jabbertown," probably on account of the mixture of Eskimo and English languages spoken there. The oldest whaling station, known as "Coopers," was established in 1887. There is also a smaller station owned by Joseph Tuckfield[b] on the north side of the point at the entrance to Marryat Inlet. One of these whaling stations, that of James Allen at Jabbertown, is shown in Pl. III, *B*.

An Episcopal mission and school has been maintained for several years at Tigara and a Government schoolhouse was built near Coopers station in 1904.

The total population in the various settlements at Point Hope is probably about 300, all but 20 or 30 of whom are natives.[c]

[a] According to Lieutenant Ray Point Hope is called "Tikera" by the natives of Point Barrow. This is also their word for the forefinger. Report of the expedition to Point Barrow, Alaska, 1885; 48th Cong., H. Ex. Doc. No. 44, p. 55.

[b] A reference to Tuckfield's explorations in northern Alaska is made by Lieutenant-Commander C. H. Stockton in the Arctic cruise of the U. S. S. *Thetis*: Nat. Geog. Mag., vol. 2, p. 183.

[c] Capt. E. E. Smith estimated the native population at Tigara in 1880 at 276: Tenth Census, vol. 7, p. 4. Henry D. Woolfe estimated the population at Tigara in 1890 at 295: Eleventh Census, Alaska, p. 158. Lieutenant Bertolf, 1898, puts the population of Tigara at 250: Cruise of the U. S. revenue cutter *Bear*, p. 25. The Twelfth Census puts the population of Point Hope village at 623: Twelfth Census of the United States, 1900, vol. 1, 1901, p. 426.

The settlement is evidently very old, for the graveyard contains the ruins of thousands of graves. According to tradition the village had a population of 2,000 in the later part of the eighteenth century,[a] but wars with neighboring tribes and diseases and vices introduced by the whalemen who had their rendezvous there have reduced it to the present number.

Near Cape Thompson there is a small native village whose population was estimated at 40 in 1880,[b] but it has not been mentioned in census reports since then. There is also a small village of two houses at Wevok, 2 miles east of Cape Lisburne. At Corwin Bluff, 28 miles east of Cape Lisburne, the population in 1904 consisted of 3 people, the native watchman and his family.

Outside of the Cape Lisburne region the nearest important settlements are on the south shores of Kotzebue Sound, where there are two thriving towns, the distributing points for a mining region of considerable promise.[c] These towns bear an important relation to the subject of this paper, since they offer an immediate market for a limited amount of coal.

TOPOGRAPHY.

Two well-marked topographic provinces have been recognized in the northern part of Alaska—the Rocky Mountain system, including several mountain ranges and forming the western continuation of the Rocky Mountains of the United States and Canada, and the Arctic Slope region, including the part of Alaska lying north of the mountains. The Cape Lisburne hills have been regarded as the western extremity of the Rocky Mountain axis, and their geologic structure seems to verify this belief, though the topographic continuity of the mountain axis has not yet been established. The Arctic Slope region extends northward from Cape Lisburne.

By its topographic features the Cape Lisburne region can be divided into three portions—a foreland, a mountainous upland belt, and a rolling upland of moderate relief.

The first of these is the Point Hope peninsula, a triangular area about 11 miles wide at its base next to the mainland, and extending 16 miles out to sea. It consists of two low sand spits which converge near the point, the space between being occupied in part by the large lagoon called "Marryat Inlet," and in part by the delta deposits of Kukpuk River. Its total area is about 88 square miles; more than half is land; no part rises more than 20 feet above the sea. In technical language it can be described as a typical cuspate foreland.

The uplands of high relief lie east of the Point Hope foreland and extend from Cape Lisburne in a southeasterly direction to Cape Thompson. They will be referred to as the "Lisburne Hills." Mount Hamlet, 8 miles southeast of Cape Lisburne, is the highest point and attains an altitude of about 2,500 feet.

The north end of the Lisburne Hills consists of a series of dome-shaped buttes rising above a plateau about 1,000 feet high, but at the south end near Cape Thompson the plateau is only about 600 feet high, and the surmounting buttes are almost entirely wanting. That this plateau is of erosive origin is indicated by waterworn pebbles from the neighboring bed rock, which can be seen at various places on its surface. In being elevated to its present position it has suffered considerable deformation. On the east side of the Point Hope foreland it approaches sea level, but farther east it rises gradually. This deformation is shown in profile in the cliffs north of Point Hope which cut the surface of the plateau. Near the base of the peninsula the cliffs are not over 30 feet high; while at the Ears, 10 miles north, they rise 600 feet from the sea to the plateau surface. The plateau is deeply incised

[a] Stockton, C. H., Arctic cruise of the U. S. S. *Thetis* in 1889: Nat. Geog. Mag., vol. 2, pp. 195–196.
[b] Tenth Census, vol. 7, p. 4.
[c] Moffit, F. H., The Fairhaven gold placers of Seward Peninsula, Alaska: Bull. U. S. Geol. Survey No. 247, 1904.

by many short streams, which flow west into the ocean, and by Kukpuk River, which rises east of the mountains and flows through them in a narrow canyon. Some of the smaller streams in this belt occupy hanging valleys truncated by the sea cliffs, but the larger ones are reduced to base-level and have rather wide valleys at their mouths.

The northeast face of the range near Cape Lisburne is marked by a prominent escarpment about 1,000 feet in height, extending southeast from the coast for several miles, parallel to a well-defined fault in the bed rock. No topographic connection has been established between the Lisburne Hills and any mountain system of the interior, but several maps drawn for the writer by natives show a low range of hills extending eastward from Cape Thompson, which, if they exist as shown, may be continuous with the western extension of the Rocky Mountain system.

The third topographic division is a portion of the Arctic Slope province of Alaska, and lies northeast of the Lisburne Hills. It is an extensive region of low rolling hills and ridges, with occasional flat valleys of limited extent. Flat surfaces covered with rounded pebbles of local origin occur on the higher portions at elevations of 500 and 800 feet and indicate old levels of erosion. This upland is essentially a peneplain with a close adjustment of drainage and topography to bed-rock structure. It is apparently the product of erosion during two periods in which the land stood, respectively, 800 and 500 feet lower relative to sea level. When these surfaces were elevated to their present position, they also suffered some deformation, and during the latest uplift, which occurred since the Tertiary, local benches were formed along the shore and Pleistocene gravels were deposited on them. (See pp. 32-33.) Between Cape Lisburne and Cape Sabine the ridges have a uniform trend about S. 75° E., corresponding with the prevailing bed-rock structure, as is shown in Pl. VII. East of Cape Sabine the trend of the ridges is not so uniform, though it still corresponds with bed-rock structure.

An isolated mountain 1,300 feet high, about 6 miles south of Corwin Bluff, rises 500 feet above the highest erosion level noted. From this mountain the low, rolling, hilly region is seen to extend far to the east and south. About 20 miles south of Cape Beaufort there are several small mountains which rise above the surrounding country. The highest of these is probably Mount Kelly, which on all maps of Alaska published since 1900 has appeared in a position about 40 miles southeast of that indicated by bearings taken by the writer during the season of 1904. This mountain probably has an elevation of 2,500 feet and rises above the rolling upland, whose highest points scarcely attain 1,000 feet.

Along the coast toward Point Barrow, beyond the region here described, the hills become lower and the relief less pronounced, so that the undulating upland of the Cape Lisburne region merges with a plain slightly above sea level in the Point Barrow region.

Along Colville and Anaktuvuk rivers, as described by Schrader, the Arctic slope north of the Endicott Mountains shows similar features.[a]

Beginning at the northern base of the Endicott Mountains, one of the ranges composing the Rocky Mountain system, at an elevation of 2,500 feet, a gently rolling plateau extends with gradual slope northward for a distance of 80 miles to latitude 69° 25′, where at an elevation of 800 feet begins the nearly flat coastal plain which descends to the sea level at the Arctic coast 80 miles farther north. The plateau country is apparently a peneplain having a complete adjustment of drainage and topography to the bed-rock structure, which resembles that of the northern part of the Cape Lisburne region. The coastal plain, however, is probably a constructional feature since it is developed over horizontally bedded Tertiary sediments. No such

[a] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904, pp. 45-46.

constructional plain occurs in the Cape Lisburne region, though it is probable that the coastal plain at Point Barrow is of this type.

The section described by Schrader is about 350 miles east of Cape Lisburne. Similar topographic relations in the intervening country are reported by Howard and other explorers, so that the continuation of the rolling upland of the Cape Lisburne region to the east for 300 miles or more and its correlation with Schrader's Anaktuvuk Plateau can be reasonably inferred.[a] The average elevation of this upland is about 500 feet in the Cape Lisburne region and from 800 to 2,500 feet along Anaktuvuk River.

DRAINAGE.

The drainage of the Cape Lisburne region is controlled by one large river, the Kukpuk, whose basin occupies the whole inland portion, while the numerous other streams which reach the coast drain only a small part. The Kukpuk, whose name signifies big river, discharges by several mouths into Marryat Inlet, the large lagoon of the Point Hope foreland. The first 15 miles of its course above its delta is across a low plateau, in which it is entrenched to a depth of about 100 feet, and farther up it traverses the Lisburne Hills in a deep canyon, probably not less than 10 miles in length. Above the canyon it forks. The north fork, called Ipewik River, is said to rise in a large lake or series of lakes west of Mount Kelly, about 60 miles southeast of Cape Lisburne. A large northern tributary of the Ipewik rises near the northern coast line about 6 miles south of Corwin Bluff. The south fork of the Kukpuk, as represented on native maps, rises south of Mount Kelly and flows westward in a general way parallel with the north fork to its junction with it. Its headwaters can not be far from the Noatak or from the headwaters of the Kivalina, which reaches the coast south of Cape Thompson.

Between Point Hope and Cape Lisburne several small streams, none of which are over 10 miles in length, rise in the Lisburne Hills and flow westward to the coast. Between Cape Lisburne and Corwin Bluff several small creeks reach the coast, which rise in the Lisburne Hills and flow northward.

East of Corwin Bluff three larger streams, Thetis Creek, Pitmegea River, and Kukpowruk River, drain the region north of the Kukpuk basin. Thetis Creek empties into the ocean about 33 miles east of Cape Lisburne. Except for about a mile at its mouth it is not navigable even by canoe. The main creek cuts across the trend of the ridges, while its tributaries flow parallel with them, their courses determined by bed-rock structure. It rises about 16 miles from the coast, not far from the headwaters of the Ipewik.

Pitmegea River enters the Arctic a half mile west of Cape Sabine and about 40 miles east of Cape Lisburne. It is considerably larger than Thetis Creek, and, like the latter stream, it has a lagoon at its mouth, which extends inland for some distance, but except in time of freshet it is hardly navigable for canoes. It is said by natives to head in the same lake as the north fork of the Kukpuk, which lies southeast of Cape Sabine and about 20 miles inland. From its source the course of the river roughly describes a semicircle, flowing first northeast, then north, then northwest to the sea. This course is probably determined by bed-rock structure. For some distance up from the mouth the valley is reported to be broad and filled with gravels and ground ice.

Kukpowruk River flows into a lagoon which begins about 10 miles northeast of Cape Beaufort and extends along the coast nearly to Point Barrow. This river, like the others of the region, is said to rise near Mount Kelly, from which point it flows northward in a sinuous course to its mouth. Native maps show a large river, called Utukok, east of the Cape Lisburne region, which rises near the Noatak and flows north to the Arctic, near Icy Cape.

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[a] Naval explorations in Alaska, U. S. Naval Institute, Annapolis, 1900, pp. 66–77.

ROUTES OF TRAVEL.

The most frequented routes of travel are naturally by boat along the coasts. Two trails overland from Point Hope to Corwin Bluff were shown on a map drawn by natives. One of these follows the coast line northward from Point Hope and crosses the Lisburne Hills near Wevok. The other crosses the mountains by way of Kukpuk Canyon, and then follows up a northern tributary, which heads about 6 miles south of Corwin Bluff.

Winter travel between Point Barrow and Kotzebue Sound usually leaves the coast at Kukpowruk or Pitmegea River, and reaches the coast again at the mouth of the Kivalina River, south of Cape Thompson, thereby saving considerable distance.

W. T. Lopp,[a] with the reindeer herd of the Point Barrow relief expedition, followed this route in 1898. An old route through the interior from Kotzebue Sound to Icy Cape, said to have been used by the natives in years past, is up the Noatak and one of its northern tributaries to the headwaters of the Utukok, which flows into the sea at Icy Cape.[b]

GEOLOGY.

STRATIGRAPHY.

The rocks of the Cape Lisburne region are, so far as known, all sedimentary. The bed rocks fall naturally into two groups—the Paleozoic and Mesozoic—and their distribution is indicated by the topography, since the Paleozoic rocks produce the high relief of the Lisburne Hills while the Mesozoic rocks underlie the region of low relief which lies northeast of them. Pleistocene and Recent sediments and ground ice form a third group, whose greatest area is found in the Point Hope peninsula. The distribution of the various formations is shown on the geologic map, Pl. I. The general stratigraphic relations are shown in the following tabular statement:

Tabular statement of stratigraphy, Cape Lisburne region, Alaska.

Age.	Formation name.	Contact relations.	Thickness in feet.	Lithologic character.
Recent		Unconformity	50+	Sands, gravels, etc.
Pleistocene		Unconformity	50+	Gravels, silts, talus, and ground ice.
Lower Cretaceous?		Conformity	10,000+	Sandstones interbedded with shales. Nonfossiliferous.
Upper Jurassic	Corwin	Unconformity	15,000+	Calcareous and carbonaceous shales with sandstones and conglomerates at infrequent intervals. Many coal beds. Jurassic plants. No marine fauna.
Lower Carboniferous, Mississippian.	Lisburne	Conformity	3,000+	*a.* Massive limestones interstratified with white cherts. Extensive coral and bryozoan fauna.
		Conformity	1,000+	*b.* Thinly bedded shales, slates, cherts, and limestones. Fauna includes brachiopods, trilobites, cephalopods, and lamellibranchs.
		Conformity?	500+	*c.* Thinly bedded black shales, slates, and limestones. Several coal beds. Lower carboniferous flora. Brachiopod and coral fauna.
Devonian?			2,000+	Calcareous sandstones and slates. No fossils found.

[a] Jarvis, D. H., Report of the cruise of the U. S. revenue cutter *Bear:* Treas. Dept. Doc. No. 2101, pp. 67-68.

[b] Jarvis, D. H., Report of the cruise of the U. S. revenue cutter *Bear:* Treas. Dept. Doc. No. 2101, p. 72.

PALEOZOIC FORMATIONS.

DEVONIAN ROCKS.

Probably the oldest formation of the region consists of heavy calcareous sandstones and interbedded calcareous slates, which occur on the west side of the Lisburne Hills, where they form the sea cliffs for about 15 miles north of Marryat Inlet, and are exposed for about 10 miles along Kukpuk River. The heavy sandstones range in thickness from 1 to 10 feet each, while the slaty beds are usually thinner. The massive members often present schistose phases and contain secondary mica. The total thickness has not been determined, though it is certainly not less than 1,000 feet.

The structure consists of a series of broad, open folds, whose dips rarely exceed 30°. The beds being massive, the strains to which they have been subjected have been taken up in two sets of well-defined joint planes in the harder members, and a slaty cleavage in the softer. The most prominent system of jointing varies in strike from N. 20° W. to N. 50° W., and is more nearly vertical than horizontal. The other set of joints strikes northeast. The relation of jointing in the harder beds to slaty cleavage in the softer is exposed with diagrammatic clearness at the high cliffs called the Ears, about 3 miles south of Cape Dyer (see fig. 1).

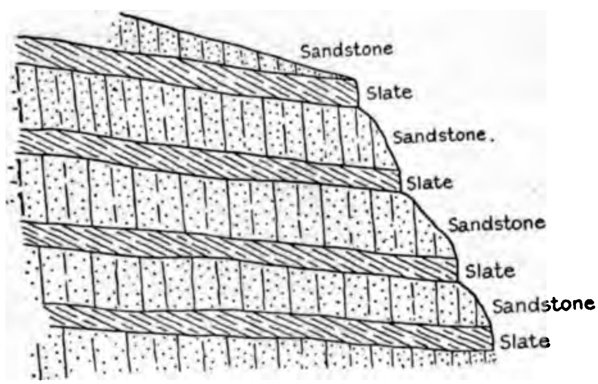

FIG. 1.—Sketch of detail of jointing and cleavage in pre-Carboniferous rocks south of Cape Dyer.

Calcite and quartz veins are often developed along the joint planes. They have been prospected in some instances, but, so far as is known, have yielded no traces of gold or silver. One of the largest seen, a calcite vein 5 or 6 feet thick near Point Hope, has furnished material which was burned by the natives and used in tanning.

The age of the formation is inferred from its relations to the Carboniferous beds which overlie it with apparent conformity, though no direct paleontologic evidence could be obtained. It is certainly older than Lower Carboniferous and is tentatively placed in the Devonian.

The Devonian rocks identified in other parts of Alaska[a] are widely distributed, but seem to be characterized mainly by great divergence in lithology, and none of them can be definitely correlated with those of the Cape Lisburne region. In the Seward Peninsula, 160 miles south of the region, there is an extensive metamorphic series consisting of schists and massive limestones which is shown by fossil evidence to be mainly of Silurian age. In the western extremity of the peninsula the rocks of this series give place to a series of slates which are in contact on their west side with Carboniferous limestones now correlated on paleontologic evidence with the

[a] Brooks, A. H., The geography and geology of Alaska: Prof. Paper U. S. Geol. Survey No. 45, pp. 218-221.

Carboniferous rocks of the Cape Lisburne region.[a] These slates, although universally finer grained than the rocks north of Marryat Inlet, bear some resemblance to them and possibly may ultimately be correlated with them.

In the Yukon River basin a widely distributed group of rocks called the Rampart formation has been assigned to the Devonian. The rocks, however, consist mainly of volcanic materials with interbedded siliceous limestones, cherts, and slates.[b] Specimens of some of these rocks collected by Prindle[c] in the Rampart region seem to be almost identical with those collected near Marryat Inlet by the writer, but the group as a whole bears no resemblance to the sandstone formation near Cape Lisburne.

CARBONIFEROUS ROCKS.

The Carboniferous rocks lie east of the area of sandstones and slates just described and constitute the mass of the Lisburne Hills. They are well exposed for 20 miles in the high bluffs along the coast south of Cape Lisburne, for several miles at Cape Thompson, and in the canyon of Kukpuk River, which flows across the Lisburne Hills. Their inland extension has not been determined, though they are provisionally correlated with some lithologically similar rocks found on Colville and Anaktuvuk rivers[d] 300 miles to the east.

The contact of these rocks with the supposed Devonian sandstones and slates has been observed at three localities. In two of these localities situated north and south the relation seems to be conformable, while in the third, 2 miles farther south of Cape Dyer, the contact is a well-defined thrust fault with the sandstone overlying (see fig 2, p. 19).

As shown on the geologic map, Pl. I, the general area of undifferentiated Carboniferous, which is approximately outlined, though its inland limit has not been determined, includes a diversity of rocks. Along the coast where the observations were in more detail three formations are differentiated, as follows: (1) A lower formation, consisting of slates, shales, and limestones, containing several coal beds, and yielding Paleozoic fossil plants. (2) Overlying the coal-bearing beds are black cherts, slates, shales, and cherty limestones containing corals and bivalve fossils, the most common being several species of *Aviculopecten*. (3) Above these beds is a great thickness of massive limestones, largely made up of coral interbedded with massive white cherts.

The shaly members of the series are usually intensely crumpled while the more massive beds present broad open folds complicated by frequent thrust faults, which make the stratigraphy difficult to decipher.

Lower formation.—The coal-bearing formation, which is the lowest, has been identified at three localities, as is shown on the geologic map. It is distinguished from the overlying formation by the presence of coal beds and of fossil plants in some of the black shales and clays. It is, therefore, essentially a fresh-water deposit. In one instance marine invertebrates have been found in such position as to suggest a possible interbedding of marine sediments with the fresh-water deposits, but as this relation may be due to the infolding of some of the overlying formations it can not be accepted as conclusive evidence. The beds are usually thin and the formation as a whole is softer than the overlying rocks. For this reason it has been more deeply eroded, so that it forms the bed rock of the indented portions of the coast and determines the positions of some of the valleys.

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[a] Collier, A. J., The gold placer deposits of Seward Peninsula. (In preparation.)

[b] Spurr, J. E., Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, pp. 155–169.
Collier, A. J., Coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, pp. 15, 16.

[c] Prindle, L. M., and Hess, F. L., The Rampart gold placer region: Bull. U. S. Geol. Survey No. 280, pp. 17–21.

[d] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904, pp. 62–67.

A. OUTCROPS OF BRECCIATED CHERTY LIMESTONE ON NORTH SLOPE OF MOUNTAIN AT CAPE LISBURNE.

B. WHALING STATION AT JABBERTOWN, ON POINT HOPE PENINSULA.

The structure in most cases consists of an intricate system of folding with faulting along the contact with the underlying and overlying formations. On the south side of Cape Dyer the coal-bearing formation seems to rest conformably on the sandstones which form the cape, while it is overthrust by the same sandstone at the Ears, about 2 miles south of Cape Dyer (see fig. 2). Between these two points the formation, which is almost continuously exposed, is closely folded, as is shown in fig. 3.

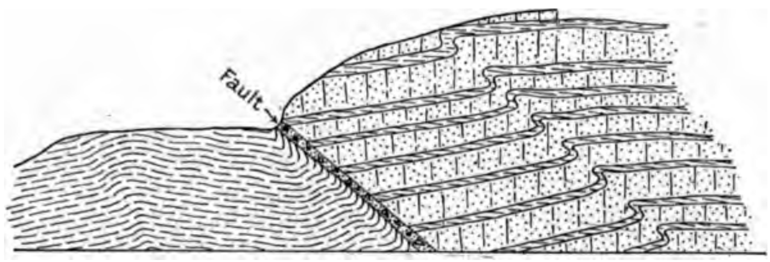


FIG. 2.—Thrust fault at the contact of Carboniferous and pre-Carboniferous rocks south of Cape Dyer.

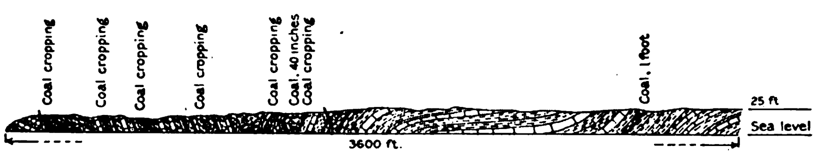


FIG. 3.—Section of Carboniferous coal formation between Cape Dyer and the Ears.

Between Cape Lewis and Cape Dyer the exposures are not continuous, but the structure seems to be more simple. The formation appears to rest conformably on the Devonian (?) sandstone of Cape Dyer and to be conformably overlain by the marine Carboniferous formations of Cape Lewis. The relation of the coal-bearing formation to the overlying rocks, as it appears at this point, is shown in fig. 4.

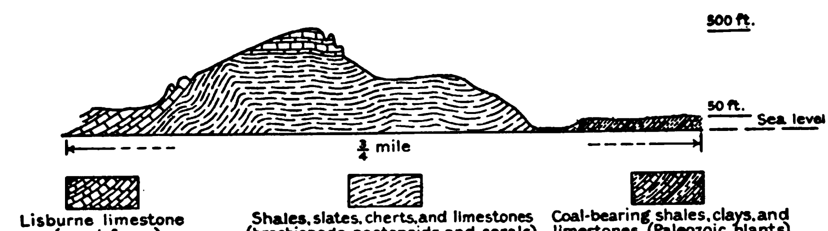


FIG. 4.—Sketch showing stratigraphic relations of the Carboniferous formations south of Cape Lewis.

Four miles south of Cape Lisburne the formation is again exposed. It is closely folded, the coal beds are sheared, and the massive limestone is thrust over it at the contact, as is shown in fig. 5.

Middle formation.—The middle formation of the Carboniferous series has also been identified at three localities along the coast. It consists of thinly bedded black slates, shales, cherts, and cherty limestones, and is distinguished from the lower formation, which it resembles in general appearance, by the absence of coal beds or fossil flora of any kind, and from the upper formation of the series, first by its lithologic character and second by its fauna, which consists principally of brachiopods and mollusks, while that of the upper consists principally of corals. In general the

formation is harder than the coal-bearing formation, and for this reason the topography produced by it is more rugged. Like the coal-bearing formation it is rather intensely folded, and faulting has usually occurred along its contacts with the massive limestones which overlie it. At the locality south of Cape Lewis it seems to rest conformably on the coal-bearing formation and to be overlain conformably by

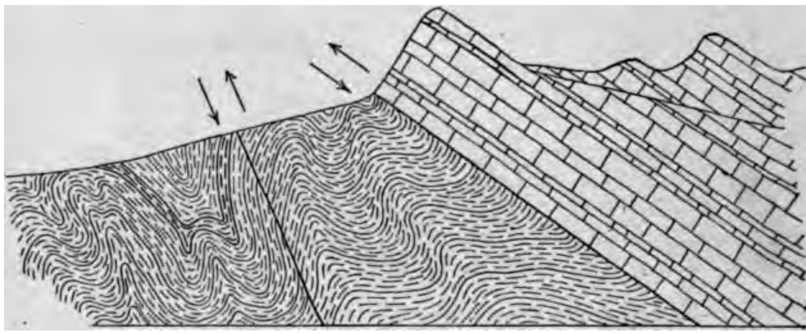


FIG. 5.—Sketch of thrust faults in Carboniferous rocks 6 miles north of Cape Lewis.

the massive limestone, as is shown in fig. 4. Its thickness here is estimated at about 1,000 feet. At a point 4 miles north of Cape Lewis the massive limestone again appears to overlie it conformably, but the coal-bearing formation is not exposed.

About 2 miles east of Cape Lisburne these rocks outcrop in a belt about 2 miles

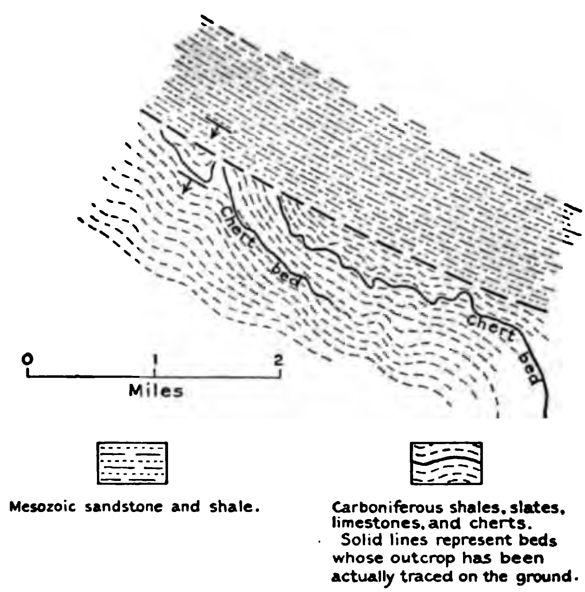
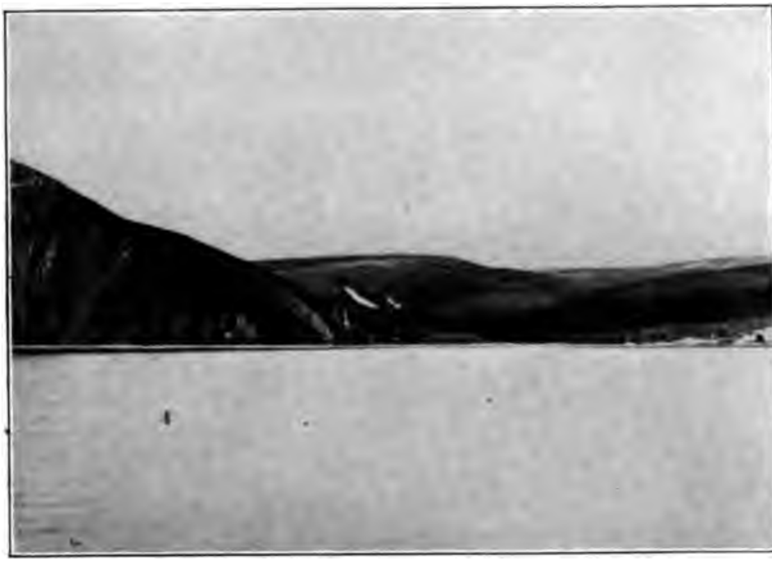


FIG. 6.—Ground plan of outcrops adjoining the probable fault contact between the Carboniferous and Mesozoic formations 3 miles east of Cape Lisburne.

wide extending southeast to the limit of this investigation. The massive limestone which forms the cliffs at Cape Lisburne seems to overlie them, but along the poorly exposed contact there is brecciation and other evidences of faulting. The slate and chert area here is marked by low hills and valleys, above which the massive lime-



A. AGATE ROCK, CAPE THOMPSON.

Photograph by Doctor Call, surgeon of U. S. revenue cutter Thetis.

B. FOLDED BEDS AND THRUST FAULT IN THE UPPER MEMBER OF THE MESOZOIC SERIES 5 MILES EAST OF CAPE LISBURNE.

stone mountains rise abruptly to an elevation of about 1,000 feet. The base of this mountain extends in a nearly straight line, which suggests a fault escarpment. In this area the sinuous outcrops of the cherty beds (see fig. 6), which can be traced for considerable distances, indicate that the formation is intensely crumpled and probably closely folded.

Lisburne formation.—The upper member of this series was called the Lisburne [a] formation by Schrader, who correlated it with the massive limestones at the head of Anaktuvuk River. It is typically exposed near Cape Lisburne, from which it takes its name, but it is also well exposed at many other localities along the coast and inland, since it is the thickest as well as the hardest formation of the series and its outcrops form the highest elevations of the Lisburne Hills. The formation consists of massive thick-bedded limestones, massive white cherts, and occasional thinner beds of black slate or shale, and is distinguished from the underlying Carboniferous formations by its lithologic character and its fauna, which consists mainly of corals. The contact relation of the upper to the middle formation of the series is conformable in an exposure south of Cape Lewis, as is shown in fig. 4, but in most of the other places where the contact is exposed faulting has occurred. The thickness exposed at Cape Lewis and also south of Cape Lisburne can not be regarded as less than 2,000 feet and may be much greater. Owing to the complicated structure and the hastiness of the field examination an exact determination of the thickness exposed was impossible. The structure consists of open folds and thrust faults. The intense folding which characterizes the two underlying formations is wanting. Fault breccia with interstitial calcite occurs near Cape Lisburne. It resembles coarse-grained por-

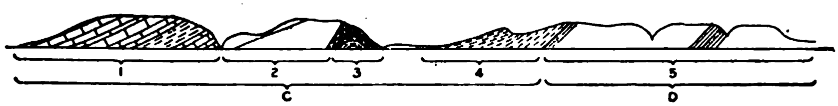


FIG. 7.—Sketch of the section exposed in the cliffs at Cape Thompson.

phyry, for which it has probably been mistaken, and perhaps has given rise to the reports of porphyry dikes near Cape Lisburne. On the north side of Cape Lisburne and also at Cape Lewis the limestone weathers into jagged pinnacles, which are shown in Pl. III, *A*.

At Cape Thompson, a locality 35 miles southeast of Point Hope, not visited by the writer, the presence of the upper two of these formations is indicated by fossils [b] which have been collected by other expeditions while the coal-bearing formation is reported by prospectors and other residents of the region. The geologic section exposed in the cliffs was sketched from the deck of the steamship *Corwin* at a distance of about 3 miles, and is shown in fig. 7. The arch in the center of fig. 7, which is called "Agate Rock," is shown in greater detail in a photograph, Pl. IV, *A*, for which the writer is indebted to Doctor Call, surgeon of the United States revenue cutter *Thetis*.

A geologic section included in the notes of Messrs. Belcher and Collie [c] of the Beechey expedition shows a relation of the two upper formations similar to that observed in several places near Cape Lisburne. The occurrence of the rocks along Kukpuk River is indicated by abundant fossils found in the gravels, though the writer did not ascend the river far enough to find the rocks in place.

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[a] Schrader, F. C., op. cit., pp. 62–67.

[b] Schuchert, Charles, Report on Paleozoic fossils from Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, pp. 898–899.
Girty, Geo. H., Report on fossil invertebrates collected by the Collier party in the Cape Lisburne region, Alaska: pp. 22–26 of this bulletin.
Hyatt, Alpheus, Report on the Mesozoic fossils: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 907.

[c] Zoology of Captain Beechey's voyage, London, Bohm, 1839, p. 173.

Several collections of fossils, made from these rocks as exposed at Capes Lisburne and Thompson previous to 1904, have given rise to various opinions as to their geologic age. The fossils collected from Cape Thompson by Belcher and Collie were determined by Professor Buckland[a] as Carboniferous, similar to the limestone of Derbyshire.

The collections of Fisher and Kupreanoff from Cape Lisburne were regarded by Grewingk[b] as in part Upper Silurian. A collection made by Dumars and Maddren in 1900 was regarded by Schuchert as of Middle Devonian age.[c] A small collection of fossil plants from the same locality was regarded by David White[d] as indicating either an Upper Devonian or Lower Carboniferous age.

A large collection of fossils, including both plants and invertebrates, from the various formations described above was made in the course of the present investigation and may be regarded as conclusive evidence that the whole series, including the three formations described, is Lower Carboniferous and should be correlated with the Mississippian series of the Carboniferous system. Reports on these collections were made by David White and George H. Girty, and are subjoined.

REPORT ON FOSSIL PLANTS.

BY DAVID WHITE.

The material, consisting almost exclusively of dark, gnarly, and slightly micaceous fire clay, comes under two field labels and comprises fragments of the following-named plants:

Lot 3553, one-half mile south of Cape Dyer; field number, 4 A C 33.

Sphenopteris frigida Hr.
Calamarian fragment (Asterophyllites ?).
Lepidodendron spetsbergense Nath.
Lepidostrobus n. sp.
Stigmaria verrucosa (Mart.) Mill.
Samaropsis spetsbergensis (Hr.) Nath.? (obscure example).

Lot 3554. Coal bed 1¼ miles south of Cape Lewis; field number, 4 A C 25.

Codonophyton sp.
Dictyoxylon sp.
Lepidodendron herri Nath.
L. veltheimianum acuminatum Goepp.
Barinophyton sp.?
Stigmaria verrucosa (Mart.) Mill.
Annularia ? sp.
Fern rhachis, fragments.
Problematical impression.

These fossil plants are evidently of Carboniferous age. Owing to the marked scarcity of filicate elements the testimony of the collection is less direct as to precise age than might otherwise be the case. However, from the evidence in hand I am forced to conclude that the plant-bearing terrane is Mississippian, and it appears probable that it is referable to the lower portion of the Mississippian. The flora, especially that of lot 3554, is very closely related to that from Bell Sound and Klass-Billen Bay in Spitzbergen. It seems to be slightly younger than the Ursa flora.

REPORT ON FOSSIL INVERTEBRATES.

BY GEORGE H. GIRTY.

The Carboniferous faunas of Alaska are different from those of central and eastern United States, and comprise either new species or ones described in more or less casual papers upon Russian or Asiatic paleontology. The paleontologist, therefore, labors under some difficulty in reporting upon such collections, since it is not only often impossible to give lists with specific determinations, but even faunal comparisons and correlations are attended with uncertainty.

The following lists embrace the species which have been discriminated at the different stations where collections were made:

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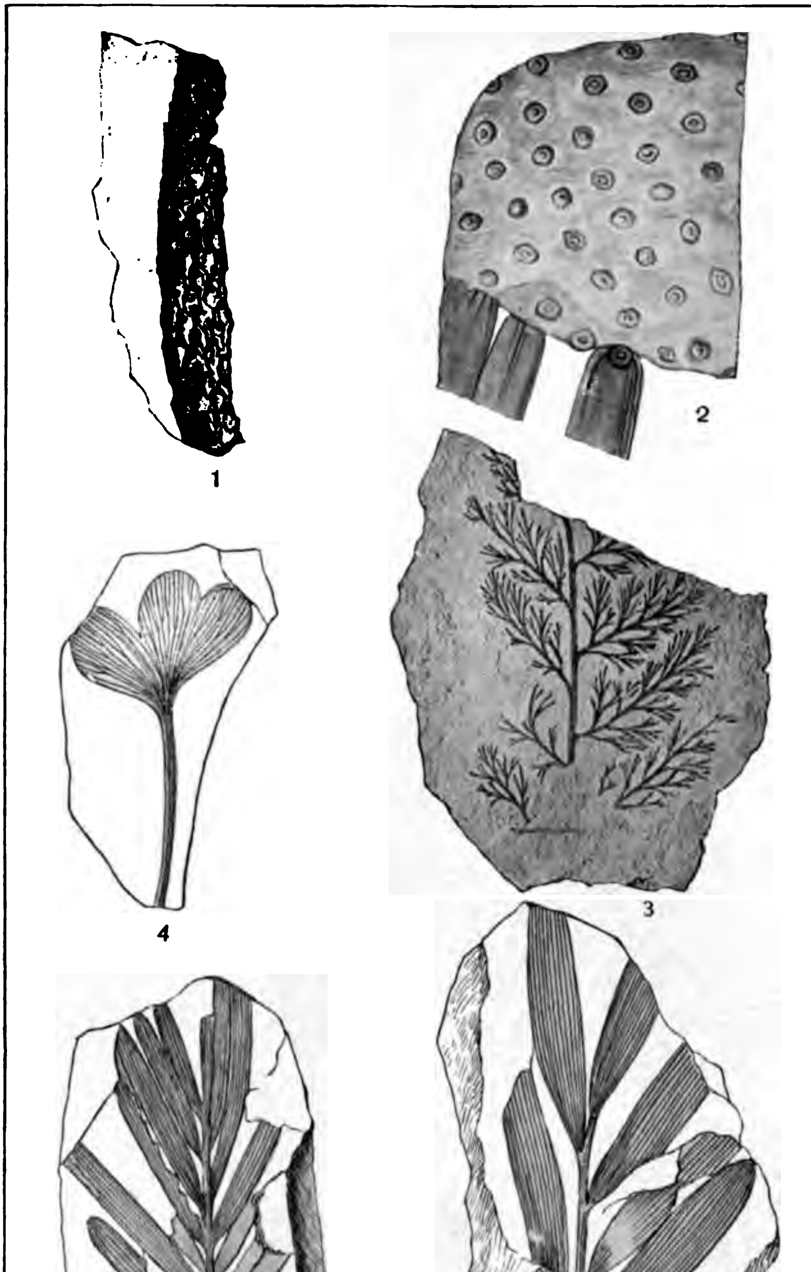
[a] Schuchert, Charles, Report on Paleozoic fossils from Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, pp. 898–900. Zoology of Captain Beechey's voyage, London, Bohn, 1839, pp. 171–174.
[b] Op. cit. pp., 898–900.
[c] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904, p. 66.
[d] Schrader, F. C., op. cit., p. 114.



PALEOZOIC AND MESOZOIC PLANTS FROM THE CAPE LISBURNE REGION, ALASKA.

Carboniferous: 1, Lepidodendron spetsbergense. 2, Stigmaria verrucosa. 3, Sphenopteris frigida.
Jurassic: 4, *Ginkgo Huttoni*. 5, Podozamites angustifolius. 6, Podozamites lanceolatus.
Figs. 1 and 3, after Nathorst; figs. 2, 4, 5, and 6, after Heer.

Station 4 A C 14, 3 miles southeast of Cape Lisburne.

Syringopora sp. a.
Lithostrotion sp. a var.
Lithostrotion sp. b.
Lithostrotion junceum.
Lithostrotion portlocki var.
Lonsdaleia ? sp. a.
Diphyphyllum sp. a.
Cleiothyris aff. C. roissyi.

Station 4 A C 15, 1½ miles southeast of Wevok.

Sponge ?
Aviculopecten 2 sp.

Station 4 A C 16, 2 miles southeast of Wevok.

Zaphrentis sp.
Productella sp.
Martinia sp.
Reticularia sp.
Aviculopecten ? sp.
Euomphalus sp.
Ostracod.
Proetus sp.

Station 4 A C 17, 3 miles southeast of Wevok.

Productus ? sp.
Productella ? sp.
Dentalium ? sp.
Goniatites sp.

Station 4 A C 18, 3½ miles southeast of Wevok.

Aviculopecten, several sp.
Nucula ? sp.

Station 4 A C 19, 3½ miles south-southeast of Wevok.

Lithostrotion sp. a ?
Lithostrotion portlocki.

Station 4 A C 21, 3 miles east-southeast from Wevok.

Aviculopecten sp.

Station 4 A C 22, 3 miles southeast of Cape Lewis.

Zaphrentis sp. a.
Lithostrotion portlocki var.
Leptæna rhomboidalis.
Productus, semireticulatus group.
Spirifer aff. S. mosquensis.
Reticularia aff. R. lineata.
Cypricardinia ? sp.
Sphenotus ? sp.

Station 4 A C 27, 2½ miles south of Cape Lewis.

Zaphrentis sp. a.
Cystophyllum ? sp.
Lithostrotion portlocki var.
Diphyphyllum sp. b ?
Productus, punctatus group.
Productus sp. b.

Station 4 A C 28, 2 miles east of Cape Lewis.

Syringopora ? sp. c.
Lithostrotion sp. a.
Lithostrotion sp. c.
Lithostrotion junceum.
Lithostrotion irregulare.
Crinoidal fragments.
Spirifer aff. S. mosquensis.

Station 4 A C 29, 1 mile east of Cape Lewis.

Zaphrentis sp. a.
Lithostrotion sp. b.
Lithostrotion irregulare.
Diphyphyllum sp. a.
Fenestella sp.
Spirifer aff. S. mosquensis.

Station 4 A C 53, 15 miles southeast from Cape Chibukak, St. Lawrence Island.

Aviculopecten sp. (Same at 4 A C 18.)

Station 4 A C 81, 4 miles southeast from Wevok.

Aviculopecten sp.

Station 4 A W 27, 4 miles east-southeast from Cape Lisburne.

Syringopora sp. a.
Syringopora sp. b.
Lithostrotion sp. a var.
Lithostrotion sp. c.
Lithostrotion portlocki ?
Lithostrotion irregulare.
Lithostrotion ? sp. ind.
Zaphrentis sp. a.
Small ind. corals.
Productus, semireticulatus group.
Productus, punctatus group.
Productus sp. b.
Rhynchonella sp.

Station 4 A W 29, 1 mile southeast of Wevok.

Zaphrentis sp. a.	Productus, semireticulatus group.
Lithostrotion junceum.	Productus giganteus ?
Lithostrotion portlocki.	Rhynchonella sp.
Syringopora sp. a.	Aviculopecten sp.
Stenopora sp.	Bellerophon ? sp.

Station 4 A W 30, cobblestone in creek east of Wevok.

Fenestella sp.	Polypora sp.

Station 4 A W 32.

Undeterminable.

Station 4 A W 33, 2 to 3½ miles southeast of Wevok.

Aviculopecten, several sp.	Pararca ? sp.
Nucula ? sp.	

Station 4 A W 34.

Aviculopecten sp.	Pararca ? sp.
Nucula ? sp.	

Station 4 A W 35, 1 mile south of Cape Lewis.

Zaphrentis sp. a.	Schizophoria sp.
Syringopora sp. b.	Productus, semireticulatus group.
Lithostrotion irregulare.	Productus, punctatus group.
Stenopora sp.	Productus sp. b.
Fistulipora aff. F. barberi.	Spirifer aff. S. mosquensis.
Fenestella 3 or 4 sp.	

Station 4 A W 36, south slope of Cape Lewis Mountain.

Syringopora sp. a.	Lithostrotion irregulare.
Lithostrotion sp. a.	Fenestella sp.

Station 4 A W 37, 2 miles north of Cape Lewis.

Fucoid.	Fenestella several sp.
Lithostrotion sp. a var.	Rhombopora sp.
Lithostrotion sp. b.	Spirifer aff. S. mosquensis.
Lithostrotion portlocki var.	Cleiothyris aff. C. roissyi.
Syringopora sp. a.	Pleurotomaria sp.

Station 4 A W 38, 2½ miles north of Cape Lewis.

Aviculopecten, several sp.	Nucula ? sp.

Station 4 A W 39, 3 miles north of Cape Lewis.

Orthotetes ? sp.	Cleiothyris aff. C. roissyi.

Station 4 A W 40, 4 miles north of Cape Lewis.

Fucoid.	Lithostrotion irregulare.
Lithostrotion sp. a var.	Spirifer sp.

Station 4 A W 44, 6 miles north of Cape Lewis.

Zaphrentis sp. a.	Pleurotomaria sp.

Station 4 A W 45, cobblestone on point of spit.

Aviculopecten sp.

Station 4 A W 46, gravels of Kukpuk River.

Lithostrotion sp. a var.	Fenestella, several sp.
Lithostrotion sp. b.	Chonetes new sp.
Lithostrotion sp. c.	Productus, punctatus group.
Lithostrotion irregulare.	Rhynchonella sp.
Lithostrotion portlocki var.	Aviculopecten sp.
Diphyphyllum sp. c.	Aviculopecten sp.

Southeast of Wevok.

Aviculopecten sp	Pararca ? sp.

Mr. Collier tells me that the stratigraphic relations of the beds are best shown at Cape Lewis, and that in this region two formations can be discriminated, a massive limestone overlying a series of thin limestones, shaly beds, and coals. If the occurrence of fossils at this point be used as a temporary standard, it appears that two more or less different faunas are presented, that from the massive limestone (represented in lots 4 A C 28, 4 A W 36, 4 A W 37, 4 A W 40, and 4 A W 44), consisting chiefly of corals belonging to the genera *Lithostrotion*, *Diphyphyllum*, *Zaphrentis*, and *Syringopora*, and that from the thinner beds (shown in lots 4 A C 22, 4 A C 27, 4 A W 35, and 4 A W 39) containing a more or less abundant representation of corals, but with numerous brachiopods and other forms. It should be remarked, however, that the corals of the soft beds are essentially the same as those of the massive limestone, while the brachiopods of the latter are essentially those of the soft beds, so that the two faunas are closely related.

As to the geologic age of these faunas I feel little hesitation in referring them to the Lower Carboniferous. The presence of *Producti* of the *punctatus* and *semireticulatus* groups, and the abundance of the genus *Lithostrotion* clearly determine the horizon as post-Devonian. The genus *Lithostrotion* is especially characteristic of the Lower Carboniferous, and in the Alaskan fauna occur several forms seemingly identical with species found in the Mountain limestone of England and the *Productus giganteus* zone of European Russia. The age, therefore, even of the heavy limestone, can safely be called Lower, instead of Upper, Carboniferous. *Lithostrotion* occurs in the underlying thin beds as well, and because these contain the species *Leptæna rhomboidalis*, whose range in the Mississippi Valley terminates with the Burlington epoch, I would be disposed to assign the beds of this division to a position low down in the Mississippian series.

An earlier collection from the same region, obtained through Mr. Schrader, was identified by Mr. Schuchert as Devonian; but since examining the later collections he agrees with my determination as Carboniferous. The earlier collection contains the following species:

Zaphrentis sp. a?
Zaphrentis sp. b.
Syringopora sp. a.
Syringopora sp. b.
Syringopora sp. c.
Lithostrotion sp. a.
Lithostrotion sp. d var.
Lithostrotion portlocki.
Lithostrotion irregulare.
Lithostrotion junceum.
Diphyphyllum sp. b.
Diphyphyllum sp. c.
Lonsdaleia sp. a.

And it is clear that if the faunal distinctions indicated by the more recent specimens hold good the fauna is unquestionably that of the massive limestone, rather than of the underlying softer, series.

In the vicinity of Cape Lisburne itself a group of collections was made which clearly represents the same horizon as that from which the Cape Lewis faunas were obtained. Here belong the following: 4 A C 14, 4 A C 19, 4 A W 27, 4 A W 29, 4 A W 44, and 4 A W 46. Several of these clearly represent the fauna of the massive limestone. In one or two instances there may be some question as to whether the faunas of the softer series are not represented.

In this same region a series of collections was obtained, representing a fauna not yet collected at Cape Lewis. In this group belong the following lots: Southeast of Wevok, 4 A C 15, 4 A C 18, 4 A C 21, 4 A C 81, 4 A W 34, 4 A W 38, and 4 A W 45. This fauna comprises little besides pectinoid shells, of which four or five species are present. It has been treated rather cursorily, because pectinoids are not good for correlation and age determination, since the number of species described is very great and it is seldom possible among Paleozic specimens to be really certain of the true generic position. I may say, however, that the types represented are such as are found in the United States in the Devonian and Lower Carboniferous. As the strata from which the present material was obtained, at one place at least, appear to be implicated with the softer beds near Cape Lewis, this horizon can pretty safely be assigned to a place early in the Lower Carboniferous. I may add that it is not uncommon to find bands filled with shells of the *Pecten* group to the exclusion of almost every other type. In the present case at some points were found in association a small smooth shell and a large vaulted one with radial ribs, similar to *Pararca*, the generic position of neither of which has been ascertained.

A small collection made several years ago at Cape Thompson (at one time identified as Mesozoic),[a] and a specimen from St. Lawrence Island (4 A C 53), though rather scanty evidence, as they show what apparently is the same species in the same sort of matrix, can with a good degree of probability be correlated with the beds about Cape Lisburne.

In addition to the faunal groups already discriminated, four species stand more or less clearly apart, although not connected with one another. They are 4 A C 16, 4 A C 17, 4 A W 30, and 4 A W 32 These, I understand, are stratigraphically related to the softer beds of the Cape Lewis section, and there is nothing in the faunas to contradict such an assignment.

The corals which constitute so large a portion of the faunas in these collections have been studied with considerable care, but as they are a difficult group, and as they can not be satisfactorily deter-

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[a] Hyatt, Alpheus, Report on Mesozoic fossils: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 907.

mined without the preparation of thin sections, my identifications must be considered to be of a somewhat preliminary character.

Every large collection of well-preserved fossils serves as a means of grouping together collections smaller in scope and those in which the preservation is inferior. Besides the material immediately referred to me a considerable number of collections were examined in order to ascertain if possible the distribution of the Cape Lisburne faunas. One of the best instances, and one with which I was already familiar, is an excellent collection made by Mr. Fred E. Wright on North Passage Peninsula, South Iyoukeen Cove, Chichagof Island. Another collection was that made by Mr. Collier in 1903 near Cape Mountain (3 A C 136).[a] These fossils have been so altered that the absolute identification of the species is in most cases impossible, but I feel little doubt that the horizon will prove to be that of the Lisburne group. Very probably the same fauna was collected by Mr. Schrader[b] on John and Anaktuvuk rivers (lots 455, 496, 498, 499, 501, 523, 524, and 533), and also from pebbles in Chandlar River (lots 2, 5, and 22). It is also suggested that the collections, 1 A C 73, 3 A H 51, and 3 A H 103 may belong to the same fauna, but the suggestion is made only tentatively, for the evidence is imperfect.

Other Carboniferous areas in Alaska.—The rocks of the Carboniferous system, including its three more important divisions, are extensively represented in other districts of Alaska, where they are usually characterized by more or less massive limestones interbedded with other marine sediments. Except in the Cape Lisburne region, no fresh-water or coal-bearing beds have been definitely assigned to the Lower Carboniferous, nor, with this exception, have Carboniferous coal beds of economic value been found in America west of the one hundred and eightieth meridian. Rocks assigned to the Mississippian series occur at only a few widely scattered localities outside of the Cape Lisburne region. On the headwaters of John and Anaktuvuk rivers, about 400 miles east of Cape Lisburne, two Carboniferous formations, the Lisburne and the Fickett, comprising a thickness of several thousand feet, have been identified.[c] The Fickett, however, is a very ill-defined subdivision, including both metamorphic and unaltered rocks. Of these the Lisburne formation can be definitely correlated with the formation of the same name in the Cape Lisburne region, while the Fickett group may in part represent a younger horizon, since from the evidence in hand it can not now be correlated with either of the formations described above.

At the western extremity of Seward Peninsula near Cape Prince of Wales there are some highly crystallized limestones and interbedded slates which may be correlated with a reasonable degree of certainty with the Lisburne limestones,[d] and on St. Lawrence Island Carboniferous rocks of the formation immediately below the Lisburne are probably represented, since drift material containing fossils of this horizon has been obtained by the writer on the island at some distance from the sea, though the rocks in place have not yet been located.

Fossils of the Lisburne horizon were also obtained last summer on Chichagof Island, southeastern Alaska[e], from a limestone formation which is so intensely folded that its stratigraphic relations to the Upper Carboniferous, which is also represented, could not be determined.

The Carboniferous rocks of the Yukon basin are apparently all younger than the Mississippian. In this province Carboniferous fossils (probably Pennsylvanian) occur on the Yukon a short distance below Eagle[f] and in a limestone area south of the Yukon Flats.[g]

[a] Collier, A. J., Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904, p. 14.

[b] Schrader, F. C., Reconnaissance in northern Alaska in 1901: Prof. Paper U. S. Geol. Survey No. 20, 1904, pp. 64-65.

[c] Schrader, F. C., op. cit., pp. 62-72.

[d] Brooks, A. H., and others, Reconnaissance in the Cape Nome and Norton Bay regions, Alaska: Special publication, U. S. Geol. Survey, 1901, p. 133.

Collier, A. J., Reconnaissance of the northwestern portion of Seward Peninsula: Prof. Paper U. S. Geol. Survey No. 2, 1902, p. 16.

Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904, p. 14.

[e] Girty, G. H., Report on the fossil invertebrates collected by the Collier party in the Cape Lisburne region, Alaska, included in this bulletin, pp. 22-26.

[f] Collier, A. J., Coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, pp. 15-16.

[g] Prindle, L. M., and Hess, F. L., The Rampart gold placer region, Alaska: Bull. U. S. Geol. Survey No. 280.

The Permian series is represented by massive limestones and other sediments[a] near Nation River on the Yukon, and a similar formation has been identified on the upper basin of White River.[b]

An Upper Carboniferous series in the northern part of the Copper River basin consists of a medium to heavy-bedded limestone, which may represent a basal portion of a calcareous terrane that continues upward to the horizon of the Permian beds.[c]

In southeastern Alaska and adjacent parts of British Columbia massive crystalline limestones, which have been referred to the Carboniferous in general and whose stratigraphic relations are difficult to decipher, are widely distributed.[d]

None of the Carboniferous formations younger than Mississippian occur in the Cape Lisburne region, though if the assignment of a part of Schrader's Fickett group to an upper horizon is correct they may be reasonably expected at points farther inland and their absence along the coast may be attributed to erosion.

MESOZOIC FORMATIONS.

The Mesozoic rocks underlie the Arctic Slope region northeast of the Lisburne Hills. They can usually be readily distinguished by lithologic characters from the Paleozoic rocks, since they consist of practically unaltered sandstones, conglomerates, and shales and contain no beds of limestone or chert. Two formations, of which the older is coal bearing while the younger is destitute not only of coal but of fossils, have been recognized. (See geologic map, Pl. I.)

CORWIN FORMATION.

The older of the Mesozoic formations, which takes its name from Corwin Bluff and the coal mines there located, is best exposed on the coast at a point 26 miles east of Cape Lisburne and thence extends northeastward to Cape Beaufort, a distance of 40 miles, which is the limit of this investigation. It is known to occur again near Wainwright Inlet[e] 100 miles beyond Cape Beaufort, and there is some reason for the belief that it is continuous to that point. The southern boundary of the formation, as shown on the geologic map, extends in a southeasterly direction from the coast for about 12 miles, where it turns to the south as shown. Beyond this the inland extension of the formation has not been determined, though statements made by explorers and prospectors seem to indicate a probability of its occurring on the headwaters of the Chipp and in the upper Colville basin, 200 miles east of the type locality at Corwin Bluff.

No contact between the Corwin formation and the Carboniferous rocks described occurs within the limits of the area under investigation, though an unconformity is evident from certain beds of conglomerate containing pebbles derived from the Carboniferous. Lithologically the formation consists of rather thinly bedded shales, sandstones, conglomerates, and coal beds. Fossil plants occur in the shales wherever they have been closely examined. The shales which comprise the greater part of the formation vary in composition from greenish-brown calcareous to black carbonaceous beds and in texture from mudstones to fine-grained sandy shales. The sandstones which occur at infrequent intervals through the formation, in beds usually less than 10 feet thick, are easily traceable over eroded areas, since their outcrops rise in relief above the surrounding shales.

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[a] Spurr, J. E., Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, p. 170.
Collier, A. J., Coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, 1903, pp. 15-16.

[b] Brooks, A. H., Reconnaissance from Pyramid Harbor to Eagle City: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 2, 1900, p. 359.

[c] Mendenhall, W. C., and Schrader, F. C., Mineral resources of the Mount Wrangell district: Prof. Paper U. S. Geol. Survey No. 15, 1903, p. 46.

[d] Brooks, A. H., The Ketchikan mining district: Prof. Paper U. S. Geol. Survey No. 1, 1902, pp. 22-24.

[e] Schrader, F. C., Reconnaissance in northern Alaska in 1901: Prof. Paper U. S. Geol. Survey No. 20, 1904, pp. 73-74.

The conglomerates are made up mainly of quartz and chert pebbles from one-half inch to 4 inches in diameter. The most definite bed of this kind, which is about 15 feet in thickness and reaches the coast at Corwin Bluff, forms a prominent ridge from 100 to 200 feet high. Its seaward end is shown in the photograph, Pl. II, *B*. This ridge, with the conglomerate of which it is composed, has been traced continuously to the southeast for about 15 miles (see Pl. VII). Since it extends in a nearly straight line and is not deeply covered by tundra growths, it is the usual route followed by the natives in traveling overland from Corwin Bluff to Pitmegea and Kukpowruk rivers, and is almost invariably indicated on maps drawn by them. On account of its persistence and the ease with which it can be traced and identified this conglomerate bed offers a definite key to the structure of the formation over a large area and indicates the absence of any extensive faults in the portion of the field shown on the map (Pl. VII).

The structure of the Corwin formation in general consists of several broad synclines and anticlines, as is shown on the geologic map and section, Pl. I. There is no evidence of faulting other than minor shearing movements parallel with the bedding planes.

The thickness of the strata exposed along the coast near Corwin Bluff is not less than 15,000 feet, as is shown in the stratigraphic column, Pl. IX, though the base of the formation is probably not shown. The formation throughout presents very little variation in lithologic character beyond the fact that in some portions of the section the shales are more carbonaceous while in others they are more calcareous. Throughout the section there is nearly the same proportion of sandy beds.

The conglomerate bed which terminates in Corwin Bluff seems to possess more distinct individuality than any other stratum examined, and it can usually be readily differentiated from other conglomeratic beds, which are neither well defined nor extensive.

Geologic notes on this formation and collections made by explorers previous to 1904 have given rise to a variety of opinions regarding its age. Mr. Collie, who first reported the presence of coal beds at Cape Beaufort, made notes and collections of fossils from which the age of the formation as exposed at Cape Beaufort was assumed by Doctor Buckland and others to be Carboniferous.[a]

The collections made by Henry D. Woolfe, who was in this region from 1885 to 1887, were examined by Lesquereux and Newberry, who regarded the age indicated as Neocomian. Professor Ward, in his enumeration of publications on Alaskan paleobotany, regarded the age indicated as Lower Cretaceous or possibly Upper Jurassic.[b]

Additional collections from Wainwright Inlet made by Schrader in 1901 were identified by Professor Fontaine and Professor Ward, who regarded the flora as not older than the oolitic of the Jurassic nor younger than the Lower Cretaceous and probably transitional between the two. The Corwin formation was therefore provisionally assigned by Schrader[c] to the Jura-Cretaceous. A very much larger and in many respects more satisfactory collection from 19 localities, representing nearly the entire thickness of the formation, was obtained by the writer and his assistants during the last season. This collection has been examined and compared with the previous collections from the Cape Lisburne region by F. H. Knowlton, whose report is subjoined.

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[a] Schuchert, Charles, Report on Paleozoic fossils from Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 900.

[b] Dall, W. H., and Harris, G. D., Correlation papers—Neocene: Bull. U. S. Geol. Survey No. 84, p. 249. Dall, W. H., Report on coal and lignite in Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 900.

Ward, Lester F., The geographical distribution of fossil plants: Eighth Ann. Rept. U. S. Geol. Survey, 1889, p. 926.

[c] Schrader, F. C., Reconnaissance in northern Alaska in 1901: Prof. Paper U. S. Geol. Survey No. 20, 1904, p. 74.

Report on Mesozoic Fossil Plants from Northwestern Alaska.

BY F. H. KNOWLTON.

From the time, about twenty years ago, when I handled the first collection of fossil plants from the Cape Lisburne region, I have been greatly interested in this flora, and have followed somewhat closely the results of its study. The present collection is in many respects the best thus far obtained, being in general ample and especially rich in fruiting ferns, and thus permits the settlement of some questions of affinity that was before impossible. The combined previous material has recently passed through Professor Fontaine's hands, and by the courtesy of Professor Ward I have been granted access to his manuscript and the proof plates which are soon to be issued in his (Ward's) Status of the Mesozoic Floras of the United States, Second Paper. I have also had access to the original material, which is now the property of the United States National Museum. Without these collections and the manuscript and plates above mentioned my work on the present material would have been greatly increased, if not made impossible, although I am compelled to dissent from some of Professor Fontaine's conclusions, as will be set forth.

There are nineteen localities represented in this collection, all apparently in the vicinity of Corwin Bluff, Cape Lisburne region. Combined they yield the following fossil plants:

Mesozoic fossil plants from Cape Lisburne region, northwestern Alaska, submitted for determination by A. J. Collier.

1. Cladophlebis Huttoni (Dunk.). Font. Abundant.
2. Dicksonia n. sp.? Most abundant of all; finely fruiting.
3. Dicksonia Borejensis Zalessky. Single specimen.
4. Tæniopteris parvula Heer. Small fragments.
5. Equisetum sp. Single stem.
6. Podozamites lanceolatus latifolius (Schenk) Heer. Many.
7. Podozamites? sp. A number of large leaflets.
8. Baiera palmata Heer. Two or three specimens.
9. Phœnicopsis angustifolia Heer. Several specimens.
10. Phœnicopsis speciosa Heer. Several specimens.
11. Pagiophyllum Kurrii (Pom.) Schimp. One or two fine specimens.
12. Stachyotaxus septentrionalis? (Ag.) Nath. One small example.
13. Taxites? subzamioides? Möller. Fragments.
14. Ginkgo Huttoni Font., n. var. Large number.

In my opinion these plants indicate a Jurassic age for the beds containing them, or at least are not younger than the Wealden. By eliminating the two forms not specifically named and the two species not satisfactorily identified, we have ten of the fourteen forms sufficiently well determined to permit of their use in fixing the age. Of these no less than seven are common to the Jurassic of eastern Siberia, not to mention other parts of the world. Of the remaining three, one (*Pagiophyllum Kurrii*) is found in the Lias of Bornholm, another (*Cladophlebis Huttoni*) in the Wealden of Hanover, and the last is what appears to be a new species of *Dicksonia*. This is the most abundant form, being found at nearly all the localities, and among them are a number of large, fine, fruiting specimens which fix definitely its systematic position. It has not been found fruiting before, and sterile portions from the upper part of the frond were identified by Fontaine as *Onychiopsis psilotoides*, while lower portions were called *Cladophlebis alata*. This *Onychiopsis psilotoides* is found in the Wealden of England and elsewhere, and the *Cladophlebis* in the Potomac formation, and as both are quite abundant in the original collections, they were much relied upon by Fontaine to prove the Jurassic-Cretaceous age of the Cape Lisburne beds. Mr. Collier's fortunate specimens show by the fruit that it is undoubtedly a *Dicksonia*, and further that the two forms of foliage occur on the same frond. The other *Dicksonia*, although a mere fragment, is with little doubt the same as *D. Borejensis* described late in 1904 from Amur. What I here called *Podozamites lanceolatus latifolius* was determined by Professor Fontaine as *P. distantinervis*, a well-known Potomac species. However, I have compared the types of this Potomac species with the specimens in hand, and can confidently say that they are not the same, and moreover that they are not separable from *P. lanceolatus latifolius*. There are also several other species identified by Professor Fontaine with Potomac species that I have carefully studied and compared, and can only conclude that he was in error, but as they are not present in Mr. Collier's collection, it is not necessary to mention them otherwise than to point out that it was undoubtedly upon these and those above enumerated that he based his conclusion as to the relationship between the Potomac of Virginia and the Corwin of Alaska. This relationship does not seem to me to exist in fact. The *Ginkgo* present in these collections is a large-leaved form that Fontaine has separated from *G. Huttoni* as a new variety, but I can at the moment see but little warrant for separating them from the widely spread *G. digitata*.

Again I state that at present I can see no valid reason for regarding this flora as other than Jurassic, or in any event as other than identical with the flora from eastern Siberia, the Jurassic age of which is, so far as I know, universally accepted.

Although there is no indication in Mr. Collier's notes that more than one horizon is represented, nor is the thickness of the beds mentioned, I have tried to see if I could detect any difference in

position. In this I have not signally succeeded. None of the localities are represented by more than five species, and most of them yield but two or three, so the basis for comparison is slight. However, I should think that localities 4 A W 5 and 4 A W 9, and possibly 4 A W 25, are probably at the base of the section.

In the light of the new evidence, and the more refined discrimination of that already in hand, presented by Doctor Knowlton in the foregoing report, the assignment of the Corwin formation to the Jurassic system can not be questioned. The determinations made indicate little or no variation in the flora through the whole thickness of the formation, since the lots indicated by Doctor Knowlton as probably near the base of the section are, on the contrary, well distributed through it. It is reasonable to expect some changes in the flora from the base to the top of a formation of such great thickness, but in this case the variation, if it exists, will probably be detected only by the paleobotanist after a critical personal examination of the section. No coal-bearing rocks of Jurassic age comparable with the Corwin formation have been found elsewhere in Alaska, and in northern Alaska no other formation yet discovered can be definitely assigned to the Jurassic, though, as indicated, the formation is probably extensive in its distribution within the Arctic Slope province.

Along the Pacific seaboard of Alaska Mesozoic beds, including Triassic, Jurassic, and Jura-Cretaceous, are extensively developed.[a] In this general region Jurassic rocks are reported from many localities distributed all the way from Dixon Entrance to the Alaska Peninsula and for 100 or more miles inland. These find their greatest development on the west shore of Cook Inlet and the south shore of the Alaska Peninsula, where Martin [b] reports a section comprising about 8,000 feet of strata, composed of shales, sandstones, conglomerates, and interbedded volcanic materials, and containing middle and upper Jurassic faunas. In the Central Plateau region of Alaska no rocks that can be definitely assigned to the Jurassic have yet been discovered.

UPPER MESOZOIC BEDS.

Southwest of the area occupied by the Corwin formation, and lying between it and the Carboniferous rocks exposed at Cape Lisburne, there is a series of beds which though they resemble the Corwin rocks are easily differentiated from them on lithologic grounds. These rocks outcrop along the coast from a point 2 miles west of Corwin Bluff to within 3 miles of Cape Lisburne and extend inland in a southeasterly direction, as shown in the geologic map, Pl. I. The exact contact of this formation with the Corwin was not exposed, or if observed its significance was not understood, though the field relations of the two formations are definitely known at a number of localities. Continuous sedimentation and conformity between the formations are indicated, though the possibility of thrust faulting along the contact should not be overlooked. This formation is therefore provisionally regarded as overlying the Corwin and constituting an upper member of the Mesozoic series. At its contact with the Carboniferous rocks near Cape Lisburne the field relations shown in fig. 6 present unmistakable evidences of a thrust fault which brings the Carboniferous above it.

Lithologically this formation consists of sandstones and shales, with the former in the ascendant. The sandstone beds range in thickness from a few inches to 20 or more feet. They resemble the sandstones of the Corwin formation, but taken as a whole are probably somewhat less gritty and contain no conglomeratic material. The shales which are interbedded with the sandstones are dark colored and sometimes micaceous, so that they have a silvery sheen on the bedding faces. In a few instances ripple marking was observed on shaly beds.

[a] Brooks, A. H., The geography and geology of Alaska: Prof. Paper U. S. Geol. Survey No. 45, 1906, pp. 225-237.
[b] Martin, G. C., Petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905, pp. 37-45, 51-53.

No definite fossils were found, after a diligent search, either in the sandstones or the shales, though indistinct impressions of vegetable fragments, probably detrital material, were found in some of the beds. The structure of the formation, while it consists of simple open folds near its boundary with the Corwin, becomes increasingly complicated as the fault at the contact with the Carboniferous rocks is approached. Overturned folds and minor thrust faults with axes extending in a general way northwest and southeast are typical features. The photograph, Pl. IV, *B*, shows folded beds and a fault with a displacement of about 20 feet, which were observed one-fourth mile from the contact with the Carboniferous.

Fig. 6, which is a ground plan of the outcrops adjoining the contact between the Mesozoic and Carboniferous, will clearly present the evidence from which the existence of a profound fault at this place is inferred. The Carboniferous rocks here consist of soft black slates and shales, with occasional beds of cherty limestone, all of which are intensely crumpled and eroded to base-level. The outcrops of several of the cherty beds were traversed and carefully mapped, and were found to end abruptly at the line of contact with the Mesozoic. The overthrusting of the Carboniferous is inferred from the observed dips in both formations and from the prevailing dips of the minor thrust faults observed in the Mesozoic formation.

Owing to the complex structure of this formation, it was impossible to definitely measure its thickness, but from the imperfect evidence obtained it is believed to be not less than 5,000 nor more than 15,000 feet, and for the purposes of this report it is estimated at 10,000 feet. Since no direct paleontologic or paleobotanic evidence was obtained, the age of the formation can only be inferred from its relation to the Jurassic Corwin formation which it overlies. It is therefore provisionally assigned to the Lower Cretaceous. On Anaktuvuk River, 400 miles east of Cape Lisburne, Schrader found a formation somewhat similar to this, both in its lithology and in its topographic relations to the Lisburne formation, which he called the Anaktuvuk series, [a] and which contains Lower Cretaceous fossils. If the above assignment is correct, the upper Mesozoic formation of the Cape Lisburne region should be correlated with the Anaktuvuk series.

Lower Cretaceous rocks, usually determined as such by the presence of a single species *Aucella crassicollis* Keyserling, are widely distributed in Alaska. [b]

On the upper Koyukuk the Lower Cretaceous Koyukuk [c] series consist of pink and reddish impure limestone, dark shale, slate, and some sandstone or arkose with occasional associated igneous rocks. On the Yukon the horizon is represented by a series of closely folded black slates, with some limestones and calcareous sandstones, which outcrop along the river for nearly 80 miles above the mouth of Charlie River. [d]

In the part of Alaska south of the Yukon Lower Cretaceous rocks are probably widely distributed, but in most cases it has not yet been possible to differentiate them from the Jurassic. No coal beds are known to occur in the Lower Cretaceous of Alaska, though the coals of Queen Charlotte Island are assigned to this series. [e]

QUATERNARY DEPOSITS.

The Upper Cretaceous and Tertiary formations, reported by Schrader [f] on Anaktuvuk and Colville rivers, 350 miles to the east but in the same general topographic

[a] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904, pp. 74-76.
[b] Brooks, A. H., The coal resources of Alaska: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1901, pp. 527-528. The geography and geology of Alaska: Prof. Paper U. S. Geol. Survey No. 45, pp. 234-237.
[c] Schrader, F. C., op. cit., p. 77.
[d] Collier, A. J., Coal resources of the Yukon: Bull. U. S. Geol. Survey No. 218, 1903, pp. 16, 17.
[e] Brooks, A. H., Coal resources of Alaska: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, pp. 526-528.
[f] Schrader, F. C., op. cit., pp. 79-83.

province, are not represented in the Cape Lisburne region, where Pleistocene and Recent deposits rest unconformably on the older rocks, occurring in limited areas, usually in the forelands between the hills and the sea, but also in a few instances extending into the river valleys. On the geologic map, Pl. I, these horizons are not differentiated from each other, not only on account of the small scale of the map, but also because the time available for their examination in the field was limited. They offer material for much interesting speculation regarding the recent geologic history of the Arctic coast.

PLEISTOCENE DEPOSITS.

The Pleistocene deposits are differentiated from the Recent by the fact that they are sufficiently elevated above the sea or the present drainage levels to form low cliffs by the undercutting of surf or river. In the Cape Lisburne region such deposits present a variety of facies. West of Thetis Creek for about 2 miles a Pleistocene deposit, consisting of about 20 feet of well-stratified gravel and sand overlain by about 1 foot of soil and muck, rests on the edges of the Corwin formation. East of the mouth of Thetis Creek for about 3 miles a deposit, consisting of silt and ground ice overlain by from 6 to 10 feet of peat and tundra vegetation, rests on the edges of the Corwin formation, which is exposed on the beach in only a few places. The ground ice does not form a continuous layer, but occurs in irregular, more or less lenticular masses, varying in composition from pure ice to frozen silt. The formation extends back of the beach for one-fourth to one-half mile in a tundra plain cut by numerous deep channels and sink holes. The process of erosion in this plain is apparently as follows: The waters from the tundra surface falling over the cliff face expose the ground ice, which melts away rapidly until the edges of the peat layer sag down and cover it. In this way a gully is started at the edge of the cliff, which works back rapidly, since the water falling into the upper end is continually exposing the ice. The sink holes occur at the heads of these gullies, where the melting of the ice has been slightly in advance of the caving in of the tundra. Gullies and sink holes formed in this way are characterized by the bending and sagging of the surface layer over the edges of the beds which have been eroded. Wherever thawing is in progress the thick layer of peat emits a fetid odor, probably similar to that described by Dall[a] at Elephant Point.

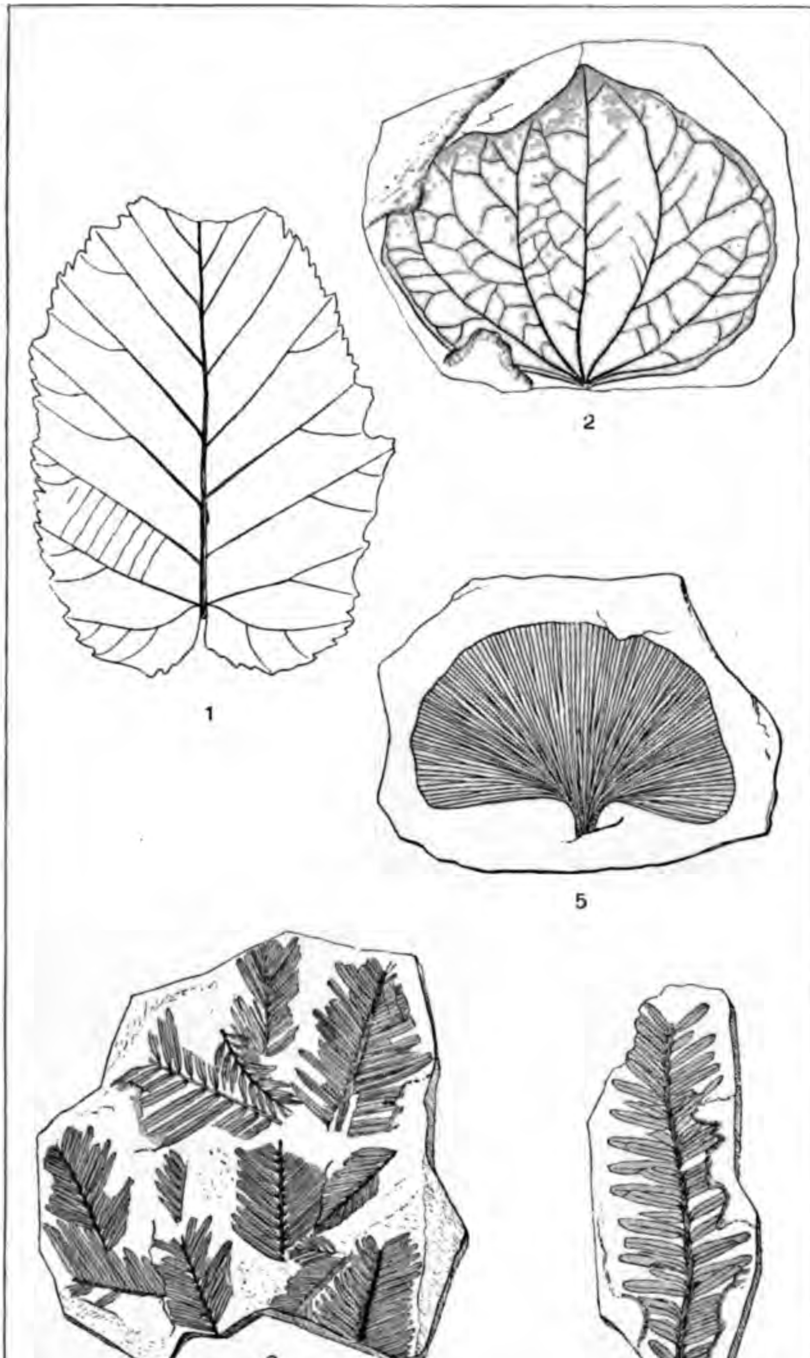
At many localities between Cape Sabine and Cape Beaufort ground ice of varying degrees of purity is overlain by gray silts and turf or talus from the hills. Where these deposits are undercut by the surf or exposed by other erosion the ice melts, undermining the formation of the bluff in broad cirque-like indentations usually less than 100 feet deep. The combined silt and water from such amphitheaters flows across the beach sands in walls of slimy mud, which are almost impassable. Vegetation over the unthawed portions of such deposits is very scanty, but along the overhanging edges of partly undermined cliffs and on the talus found below them grasses and other plants grow in comparative profusion. For about 3 miles west of Cape Beaufort there is gravel and sand free from ground ice and similar to the deposit west of Thetis Creek, which forms a bluff about 100 feet high. At one point sandstone of the Corwin formation outcrops at the base of this bluff.

On Pitmegea River a ground-ice formation, which was not examined by the writer, is described by Stockton[b] as follows:

> *Ice cliff on the Pitmegea.*—This ice cliff is about 25 miles from the mouth of the Pitmegea, at a place where the hills run their spurs out to the banks of the river, closing the picturesque valley that stretches away to the seacoast in an almost unbroken width of a mile. A glacier faces southward and receives the full benefit of the sunlight during the short polar summer. Gales have deposited particles of soil and débris of plants, along with their seeds, upon the surface of the ice to a depth of

[a] Dall, W. H., and Harris, G. D., Correlation papers—Neocene: Bull. U. S. Geol. Survey No. 84, 1892, pp. 262–263.

[b] Stockton, Charles H., Arctic cruise of the U. S. revenue cutter *Thetis* in 1889: Nat. Geog. Mag., vol. 2, 1890, pp. 178–179.



TERTIARY PLANTS FROM THE KENAI (EOCENE) FORMATION OF ALASKA.

1, Corylus McQuarrii. 2, Populus arctica. 3, Taxodium distichum miocenum. 4, Sequoia Langsdorfii. 5, Ginkgo adiantoides.
From Heer's "Flora Fossilis Arctica."

from 4 inches to 1 foot. The snowfall of winter soon vanishes before the June sun, but the light covering above the glacier preserves it intact. Vegetation is warmed into life in a remarkably short time, and the brown coat left by the receding snow is almost miraculously transformed to a robe of green, studded here and there with bright polar flowers, buttercups, dandelions, yellow poppies, bright astragals, gentians, daffodils, and marguerites. The last are small and unobtrusive, showing in a modest way as if they wished to apologize to their sister flowers for their appearance among them. As toward beautiful orphan girls one can not resist a compassionate tenderness of feeling toward them. But these innocent little flowers, chaste as the ice field upon which they grow, bloom in the polar garden with as much right as the glacier's gentian. Besides flowers, there are the hardy grasses whose roots penetrate the light covering of soil to the ice bed, whence they derive their nourishment. A few Arctic willows are to be seen, but they only grow about a foot in length and trail upon the ground. Pitmegea River is gradually cutting into the glacier, receding from its opposite bank and leaving a bed of gravel behind. During the summer the ice melts away, leaving the soil protruding above it like the eaves of a house; when it protrudes too far for the strength of the grass roots it topples over into the river. At the freezing in September icicles form from the overhanging sod to the river ice below, forming a narrow portico 4 miles in extent.

None of these deposits, either of ice or gravel, are traceable to typical glaciers nor to any particular part of the Glacial epoch. They belong to the group of beds called Kowak clays and ground ice by Dall and others,[a] which are widely distributed over the nonglaciated parts of Alaska and Siberia.

No fossil remains were found in place in any of these deposits, but fragments of the tusks and teeth of the mammoth, *Elephas primigenius*, were observed at two places in gravels directly derived from their localities. Their assignment to the Pleistocene series is therefore unquestionable.

RECENT DEPOSITS.

The deposits which have not been elevated above sea level, and are still in process of construction, are of two kinds—alluvial plains and marine beaches. The only considerable area of the former type is found in the delta of Kukpuk River, while the beaches form a fringe of varying width along nearly the whole coast. The largest area, about 80 square miles in the Point Hope peninsula, is in part a delta and in part a beach deposit.

The Kukpuk delta which forms the interior portion of this area is a plain from 10 to 15 feet above sea level. In its upper part, which alone is exposed, the deposit consists of stratified silts and sands overlain by peat and tundra vegetation, and its surface is broken by numerous lakelets and abandoned channels. It is reported that a large part of the area is underlain by ground ice, but of this the writer has no knowledge from his own observation. Along Kukpuk River the bed rock is exposed below the silts in several places, and it is not probable that the depth of the formation at any point exceeds a few fathoms. The sediments brought down by the river each year contribute to the extent of this formation at the expense of Marryat Inlet. The lands along the coastal margin of the Point Hope peninsula, which separate Marryat Inlet from the sea, are deposits of the latter type, and consist of two sand and gravel spits which extend seaward from the north and south sides of this delta and converge and meet about 15 miles from the mainland. They vary in width from a few hundred feet to a mile, rise from 10 to 15 feet above sea level, and, except in time of unusually severe storms, are entirely beyond the reach of the waves. A native graveyard located near Tigara has not been disturbed by sea waves for several generations, but during severe storms waves break over some of the narrower portions and the water of the inlet is never fresh. In addition to these two main spits there

[a] Dall, W. H., and Harris, G. D., Correlation papers—Neocene: Bull. U. S. Geol. Survey No. 84, 1892. (Map opposite page 268.)
Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904, pp. 91-93.
A comprehensive review of the literature regarding this interesting formation both in Alaska and Siberia has recently been prepared by A. G. Maddren under the title "Smithsonian Exploration in Alaska in 1904 in search of mammoth and other fossil remains:" Smithsonian Misc. Coll., vol. 49, No. 1584, 1905.

are several gravel bars in Marryat Inlet which curve northward from its southern shore and are exposed only at low tide. These have not been definitely located on the map, but are mentioned, since they probably indicate previous stages in the development of the point.

The surface materials vary from moderately coarse sand to well-rounded gravels with some pebbles 3 inches or more in diameter. As far as observed, all this material is traceable to the Paleozoic formations of the neighboring mainland and a large part of it may have been contributed by Kukpuk River. These spits are probably in the main the product of the waves and prevailing currents. The material for the south spit was derived from the cliffs at Cape Thompson and the delta of Kukpuk River. It was worked northward by the prevailing current which swings off from the shore at this point, partly on account of the angle in the coast line and partly on account of the growing delta of the Kukpuk. The counter current or eddy on the north side of the Kukpuk delta was at the same time bringing material for the north spit from the cliffs south of Cape Lisburne. This spit was of slower growth than the south spit which curved northward from its extremity, forming the bars noted in Marryat Inlet. As the north spit extended beyond these bars the south spit extended in its present direction. The two come together about 15 miles from the mainland and 1½ miles from the point. It is reported that the point is still growing seaward, but of this the writer has no definite evidence.

In the region explored east of Cape Lisburne there are several barrier beaches shutting in narrow lagoons behind them, none of which are of considerable extent. The largest, which lie between Cape Lisburne and Corwin Bluff, are not over 2 miles in length and one-fourth mile in width. About 10 miles north of Cape Beaufort a lagoon of the same type but of greater width begins and extends along the coast continuously for over 100 miles. As was stated in connection with the sand spits at Point Hope, such barrier beaches are usually attributed to the action of waves and currents. In the Arctic Ocean, however, the action of the grounded ice pack on such beaches must be taken into consideration. As has been already noted (pp. 10–11) the ice pack occupies about half the depth of the Arctic Ocean and will ground at from 3 to 6 fathoms, or in most cases from 1 to 2 miles offshore. If, then, the ice pack is driven ashore by the wind so that the ice banks up along the beach, as sometimes happens, a great deal of material from the sea floor may be scraped up and added to the beaches. At Blossom Shoals, several miles off Icy Cape, about 100 miles northeast of Cape Lisburne, the soundings show a succession of ridges parallel with the coast. These have gentle slopes on their seaward side and steep slopes landward, and shift their positions from year to year. They are attributed to the action of the grounded ice pack, and if the facts are as represented this conclusion is warranted.

The writer was informed by Joseph Tuckfield, who resides near the entrance to Marryat Inlet at Point Hope, that his residence has been more than once threatened by the driving ashore of the ice pack; and Dr. E. O. Campbell, Government school teacher at Cape Chibukak, St. Lawrence Island, whose residence is nearly one-half mile back of the beach, reports that he has often feared the destruction of the mission buildings from the same cause. The beach at Cape Chibukak is marked by a series of regular ridges parallel to the shore, said by Doctor Campbell to have been pushed up by the ice pack. In view of these considerations the barrier beaches of the shores of the Arctic Ocean and Bering Sea, though in nearly all respects they resemble the barrier beaches formed by wave and current action in southern latitudes, must in the opinion of the writer be regarded as in part due to material pushed up from the sea floor by the ice pack and only transported in a minor degree by wave action. Barrier beaches of this type are of common occurrence along the shores of the Arctic Ocean in Alaska from Cape Prince of Wales to McKenzie River.

ECONOMIC GEOLOGY.

INTRODUCTION.

The only mineral resources of the region which are believed to be of economic importance are the coal deposits. As has been shown the rocks are all of sedimentary origin and comparatively unmetamorphosed. It is, therefore, not considered probable that any important deposits of either gold or silver occur in them, though gold-bearing veins have been reported from the head of Pitmegea River.[a]

Coals have been found in Alaska and adjacent parts of British Columbia in not less than five geologic horizons. These are Carboniferous, Jurassic, Cretaceous, Tertiary, and Quaternary, representing the three geologic eras, Paleozoic, Mesozoic, and Cenozoic.

Of these only the Carboniferous, Jurassic, Cretaceous, and Tertiary have been found of economic value. As a general rule, other things being equal, the older coals are of better quality than the younger.

The age of the coals is indicated by the character of the plant remains and other fossils found in the underlying and overlying bed rock. Since it is of value to prospectors to be able to distinguish within very broad limits as to which of these major divisions the coal which he may have discovered belongs, a few remarks as to some of the principal types which characterize these various divisions will be here incorporated. The land plants from which the Paleozoic coals were formed were mostly ferns and relatives of the club-moss family (Lycopodiaceæ). Some of these ancient representatives of the lycopods, or "ground pines" as they are often called, were of great size, resembling in some respect the evergreens of the present day. Two of the most common and characteristic of these were *Lepidodendron* and *Sigillaria*. The small leafy twigs of the former often suggest branchlets of the cypress or yew, but the fragments of larger stems (Pl. V, *A*), which are more common, have their bark marked by more or less elongated diamond-shaped meshes or "bolsters," in the interior of each of which is situated a small, usually rhomboidal, leaf scar. The large stems of *Sigillaria*, on the other hand, are characterized either by rather broad flat ribs, each rib bearing a longitudinal row of scars, or by a more or less distinct series of relatively large hexagonal meshes or cushions containing the leaf scars. In general, the presence of fossils of these types is most often made known by the occurrence of fragments of their characteristic roots, *Stigmaria* (Pl. V, *B*), which can be easily recognized even by amateurs by the circular depressions, each of which contains a small round prominence surrounded by a smooth circular border. These pits correspond to the points of attachment of long, ribbon-like or fistulose radiating rootlets, which resemble slender leaves but have become distorted in most instances.

The shales associated with the coals belonging to the same group as the older (Paleozoic) coals of the Cape Lisburne region usually contain fragments of a delicate and finely dissected fern (*Sphenopteris*), similar to that shown in Pl. V, *C*. Though the size and shape of the pieces of frond may vary greatly, the slender lobes of the delicate, sometimes lax, pinnæ are not difficult to recognize. Specimen fragments of the fern, or of *Lepidodendron* and *Sigillaria*, are most apt to be found in the shales or slates just above coal seams; but the *Stigmaria* roots are more common in the underclays of the Carboniferous coals.

The Mesozoic era is also characterized by ferns and palm-like plants with parallel-veined leaves, but *Lepidodendron* and *Stigmaria* are always wanting. The Jurassic and Lower Cretaceous horizons of Alaska can be recognized by the presence of plants called "cycads," leafy branches of which are shown in Pl. V, *E* and *F*. The cycads, which perhaps are most closely related to the conifers, have usually short,

[a] Stockton, Charles H., Arctic cruise of the U. S. revenue cutter *Thetis* in 1889: Nat. Geog. Mag., vol. 2, p. 171.

thick trunks with a circle or crown of large pinnate leaves at the top, the lower portions of the trunk being covered with usually large, rudely diamond-shaped scars, which represent the places whence earlier leaves have fallen. The leaves look much like those of certain palms, having a thick midrib or axis, along the sides of which are arranged the narrow parallel-veined leaflets. There are never any dicotyledons associated with the cycads in these beds, though there are often ferns and horsetails (*Equiseta*).

The Upper Cretaceous horizons contain cycads associated with plants of more modern aspect called "dicotyledons"—that is, plants having netted-veined leaves, such as the oak, sassafras, sycamore, poplar, etc. These are also plants with palmate leaves such as those of *Ginkgo*, shown in Pl. V, *D*.

The fossil plants of the Cenozoic era, including the Eocene, Miocene, and Quaternary horizons, include few if any plants with parallel-veined leaves, except occasional grass or sedge-like types. The era is characterized by dicotyledonous plants, such as oaks, poplars, and the host of other deciduous trees, shrubs, and herbs, as well as by conifers of the Redwood type. Plate VI shows some of the characteristic plants from the Eocene (Kenai) series, the most extensive Cenozoic coal-bearing formation in Alaska.

In the Cape Lisburne region coals of two distinct types occur in rocks of Paleozoic and Mesozoic ages. The Paleozoic coals are bituminous and of a very high grade, but are of limited extent. The Mesozoic coals are also bituminous, but of low grade. They are distributed over a large field, and on account of the thickness and extent of the beds are of greater economic importance than the older coals.

THE MESOZOIC COAL FIELD.

EXTENT.

The Mesozoic coals occur in the Corwin formation, which is known to be of Jurassic age. Its extent within the region investigated is shown by the geologic map (Pl. I). The southern boundary of the formation runs in a southeasterly direction from the coast for about 10 miles, beyond which it turns south. The same coal has been found in the interior 20 miles south of Cape Beaufort, and similar coals have been reported to occur on the headwaters of Colville and Chipp rivers, 300 miles east of Cape Lisburne. Its continuity through this distance has not been determined, though it may be inferred from topographic evidence. It is safe to say that the coal-bearing area is not less than 300 square miles, while it may be found to be much greater.

The topography of this field consists of low rounded hills and ridges usually less than 600 feet in elevation, which trend parallel with the strike of the bed rock and are formed by the outcrops of harder beds. The portion of this field which lies between Corwin Bluff and Cape Sabine (see map, Pl. VII) contains the only mines in the region which have been worked, and has been examined in somewhat more detail than the remainder.

The distribution of the coal beds as well as the relation of bed-rock structure to topography is shown in the map (Pl. VII), which is based on field notes made by the writer. From this map it will be seen that a well-defined ridge extends southeastward from Corwin Bluff. This ridge is formed by the outcropping of a persistent conglomerate bed which, as already stated, gives a definite key to the stratigraphic relations. The continuance of the coal beds away from the coast line is inferred from the continuance of this conglomerate, and croppings of coal back from the coast have been observed at only the few points which are indicated. The vertical distribution and approximate number of the coal beds is shown in the columnar section (Pl. IX). Many of these beds are known only from obscure croppings and only a few of them have been sufficiently developed to permit accurate measurement or sampling.

THE COAL BEDS.

The beds which have been found to be of economic importance fall readily into two groups, the Corwin and Thetis, though further development may show that the intervening strata also contain some workable coals. Those which seem to be of value are described in order from the top of the formation downward, while in the portions of the field not covered in the map (Pl. VII) the croppings of coal which have been observed are described without reference to stratigraphic position.

CORWIN GROUP.

The coal beds of the Corwin group outcrop in the sea cliffs east and west of Corwin Bluff, which is a cliff 200 feet high about 28 miles east of Cape Lisburne. The bluff itself rises sheer from the water, but about half a mile west of it there are narrow rocky beaches along the foot of the cliff, and a few hundred yards east there is a short sand beach at the mouth of a small creek. The bedding strikes N. 75° W. and dips about 40° southeast.

The highest coal seam noted in the series outcrops in the sea cliff 1⅜ miles west of Corwin Bluff. It is exposed by a recent rock slide from the cliff and contains 4½ feet of coal without partings. The roof and floor are soft shales or shaly sandstones.

A sample of this coal taken by Washburne, numbered 4 A W 7, was assayed by W. T. Schaller with the following result:

Analysis of coal from sea cliff 1⅜ miles west of Corwin Bluff, Alaska.

	Per cent.
Fixed carbon	40.80
Volatile hydrocarbon	41.30
Moisture	13.55
Ash	4.33
Sulphur	.40
	100.38
Coke	None.
Color of ash	Gray.
Fuel ratio	0.96

A second seam which has yielded some coal is about 1,000 feet lower stratigraphically, the intervening beds being shales which contain several coal seams either too small or too impure to be of value. This bed outcrops in the sea cliff three-fourths of a mile west of Corwin Bluff and is developed by a tunnel about 40 feet long driven without timbers. The photograph (Pl. VIII), which is probably of this bed, is taken from Schrader's report and shows the nature of the development work done in 1901.

The seam is 5 feet thick and has two thin clay partings, one 1 foot from the floor, the other about the middle. The roof is shaly sandstone which stands well without timbers. The floor is hard clay or clay shale and contains a smaller seam several feet below the one that has been developed.

A sample of this coal taken by the writer across the bed as exposed in the face of the tunnel, excluding the two partings, was assayed by W. T. Schaller with the following result:

Analysis of coal from sea cliff three-fourths mile west of Corwin Bluff, Alaska.

	Per cent
Fixed carbon	42.06
Volatile hydrocarbon	37.72
Moisture	11.18
Ash	9.04
	100.00

	Per cent.
Coke	None.
Color of ash	Light gray.
Fuel ratio	1.11

The coal in the face of the tunnel is solid, and though frozen does not break up greatly on exposure to the air. A sample exposed to the air for several months in the office is still solid except for some cracks, which may be due to other causes than evaporation, but a sample which had been thoroughly air-dried in the office for several months slacked to fine grains when again put in water. When finely powdered the coal loses moisture rapidly, so that an assay made from a portion of a sample which had been ground in an agate mortar showed only 4.66 per cent moisture as compared with the 11.18 per cent obtained from coarsely-ground material. The specific gravity of a sample of the air-dried coal was roughly determined to be 1.39.

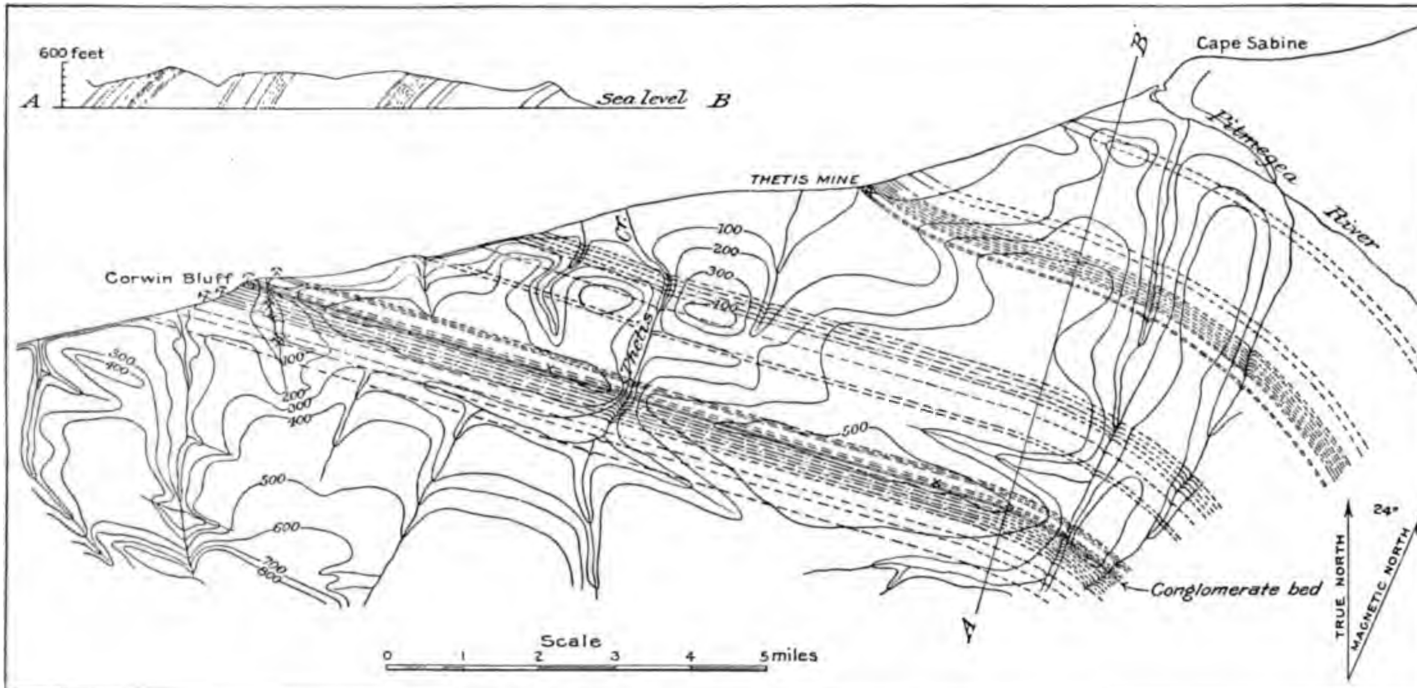
The next bed of importance is about 500 feet lower stratigraphically, the intervening beds being shales which contain 4 or 5 small, unimportant, coal seams. This is probably the original Corwin vein and has yielded a considerable amount of coal. It has been developed by a tunnel from the cliff face and an air shaft from the level surface above the cliff which is about 75 feet above the sea. In the summer of 1904 the entrance to the tunnel was closed by a great mass of ice, the remnant of snowdrifts formed the winter before, and the air shaft was filled with water, so that the workings were inaccessible and the coal bed could not be measured. It is reported to have a total thickness of 16 feet, of which 7 feet is clear coal with no partings, while the remainder contains several partings and is without value.

Two samples were taken by the writer from sacks of coal mined the year before, which were found frozen in the ice at the foot of the cliff. One of these (No. 4 A C 4) is a fair sample of the material found in the coal sacks, and represents the coal as it has actually been mined and shipped. The other sample was taken from the same sacks but was washed before sampling. It probably represents approximately the quality of coal that could be obtained from this bed by careful mining. The analyses by W. T. Schaller are as follows:

Analysis of coal from sea cliff west of Corwin Bluff, Alaska.

	No. 4 A C 4. Per cent.	No. 4 A C 5. Per cent.
Fixed carbon	41.67	47.49
Volatile hydrocarbon	37.49	39.08
Moisture	9.45	9.49
Ash	11.39	3.49
Sulphur	.30	....
	100.30	99.55
Coke	None.	None.
Color of ash	Gray.	Light gray.
Fuel ratio	1.11	1.21

The coal from this bed which was examined was mined about a year before and since then had been subjected to alternate freezing and thawing. Most of it, though not all, was in small pieces. The samples which were brought to the office have not broken up perceptibly. A finely pulverized sample, when assayed, contained only 4.49 per cent moisture as compared with 9.49 per cent in the coarsely ground material. Below this bed there are shales for about 1,000 feet between it and the conglomerate bed which forms Corwin Bluff. In this shale there are 8 beds of coal, indicated by croppings, which could not be examined in detail, since their exposures in the cliffs were inaccessible. Three of these beds seemed to be over 4 feet thick. One, which immediately overlies the conglomerate, appears from the sea



MAP OF PART OF CORWIN COAL FIELD.

Showing position of coal croppings and relation of topography to bed-rock structure.

to be about 30 feet thick and of impure coal. Another about 12 feet thick and a third 4 feet thick are reported to be clean coal of good quality. The conglomerate bed at Corwin Bluff is from 10 to 20 feet thick.

Immediately below the conglomerate, and lying between it and a massive sandstone, there is an irregular coal bed from which, it is reported, 500 tons of coal were taken in one season. This bed has been affected by shearing movements of the adjacent strata, and the coal is brecciated and polished, though it can be obtained in large pieces. In other parts of the series the adjacent shales are soft beds which have yielded equally to shearing strains, so that the coal beds have remained comparatively unaltered. But in this case, the conglomerate and sandstone beds being rigid, the whole effect of such forces has been felt by the coal bed which lies between them. In the face of the bluff the coal appears in a series of isolated masses, as shown in the sketch (fig 8), which is parallel with the strike of the bedding.

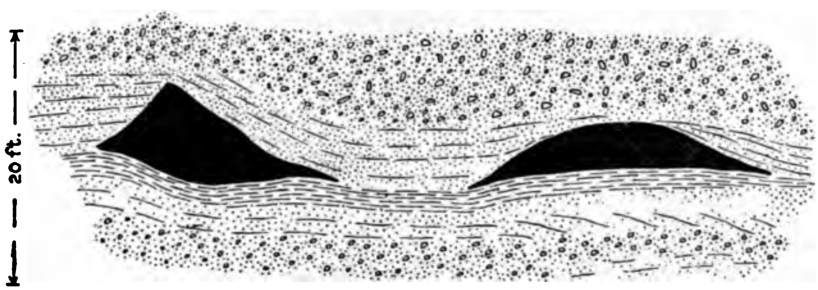


FIG 8.—Section of irregular coal bed underlying the conglomerate at Corwin Bluff.

Since this bed was partially mined out the face of the bluff has fallen down, making the coal inaccessible, and the samples for analysis were taken from large pieces which had fallen down, and may not be fully representative. The result of the analysis by Schaller is as follows:

Analysis of coal from Corwin Bluff, Alaska.

	Per cent.
Fixed carbon	57.49
Volatile hydrocarbon	34.59
Moisture	4.49
Ash	3.43
Sulphur	.39
	100.39
Coke	None.
Ash	Gray.
Fuel ratio	1.63

Specimens of this coal which were found on the talus at the foot of the cliff and had probably been long exposed to the weather seemed to be entirely unaffected. The specific gravity of a sample which had been exposed to the air for several months was roughly determined to be 1.30. While the analysis indicates that this is the best coal sampled from the Corwin formation, the irregular nature of the bed makes it doubtful if it can ever be profitably worked.

The next bed of importance in the series outcrops in the sea cliff about 1,000 feet east of Corwin Bluff, and is stratigraphically 400 feet below the conglomerate bed, the intervening strata being sandstones and shales containing many plant remains, and one small coal bed below the irregular one noted above. The section of the coal bed from the top down is as follows: Clean coal, 1 foot; black shale, 1 foot; clean coal, 4 feet. The coal from the upper and lower benches is about alike.

The roof of this bed is black shale 1½ feet thick, above which is shaly sandstone. The floor of the bed is black shale 2 feet thick, below which there is 1 foot of impure limestone.

This bed has been partially opened at the top of the cliff, which is about 100 feet high, and has yielded for whaling ships some coal said to be of good quality. The face of the cliff up to 75 feet above the sea was covered in July and August, 1904, with snow and ice, the remnant of snowdrifts accumulated the winter before.

A sample across the bed was taken by the writer, excluding the shale parting noted above. The result of its analysis by Schaller is as follows:

Analysis of coal from sea cliff east of Corwin Bluff, Alaska.

	Per cent.
Fixed carbon	48.47
Volatile hydrocarbon	33.40
Moisture	12.45
Ash	5.68
	100.00
Coke	None.
Color of ash	Light gray.
Fuel ratio	1.45

The sample was taken from the croppings of the bed, where it was considerably broken up by weathering.

About 50 feet below this bed there is an undeveloped bed which appears from the croppings to be about 2 feet thick. Below this for about 8,000 feet no coal beds above 1 foot in thickness were observed by the writer, though thin beds have been noted at several places, as will be seen from the section, Pl. IX.

THETIS GROUP.

The coal beds of the Thetis group outcrop on the coast 6 miles east of Corwin Bluff, and are stratigraphically about 8,000 feet below the lowest bed of the Corwin group.

The outcrop along the coast is near a sandstone cliff about 30 feet high, the seaward end of a low ridge which extends inland in a southeast direction. It is about 4½ miles west of Cape Sabine and 2 miles east of the mouth of Thetis Creek. The coal here is reported to have been worked first by a whaleman who found all the beds accessible at Corwin Bluff already occupied by the crews of other ships, and was directed to this place by natives. The United States revenue cutter *Thetis* coaled here in 1888. It is reported that when the bed was discovered its outcrop extended across the beach, standing above the sand, and a large amount was easily obtained. In 1904 extensive snowdrifts covered the beaches and the cliff face so that no outcrop was seen. The bedding strikes N. 60° W. and dips southwest at an angle of about 20°.

The vein which was worked in 1888 is probably one that overlies the massive sandstone which forms the cliff noted. Croppings on the level ground above the bluff indicate two coal beds of considerable thickness with 15 or 20 feet of shale between. Reports of the workings indicate that the vein has a thickness not less than 6 feet. In about 700 feet of dark shales underlying the sandstone bed ten coal beds were noted, only two of which are of possible economic value.

The first of these is about 250 feet below the Thetis bed, and outcrops about 100 feet east of the high sandstone cliff. It contains 4 feet of clean coal without partings, and has for roof and floor black shales which contain several small coal seams. A sample across this bed, where it was exposed by the undercutting of the surf on the cliff, was taken by Mr. Washburne, and was assayed by W. T Schaller with the following result:

PARTLY DEVELOPED COAL BED AT CORWIN BLUFF.

Analysis of coal from Thetis mine, Alaska.

	Per cent.
Fixed carbon	46.27
Volatile hydrocarbon	35.60
Moisture	13.61
Ash	4.52
	100.00
Coke	None.
Color of ash	Light brown.
Fuel ratio	1.30

As is noted above, the sample was taken from a natural exposure which was frequently drenched by the waves, and the quality of the coal may have been slightly affected. The coal in the croppings is broken up into small pieces.

A second seam which appears to be of workable size is about 200 feet lower in the column and outcrops about 600 feet farther east. It contains 3 feet of clean coal without partings, below the same thickness of bony coal which is probably worthless. No analysis was made of the sample from this bed.

Below the beds of the Thetis group there are about 3,000 feet of shales and sandstones, outcropping between Thetis mine and Cape Sabine, in which several coal beds have been noted, but none are of commercial value. East of Cape Sabine the structure changes, so that the outcrops of the beds described above are probably repeated, but the work has not been sufficiently detailed to identify them. The coal-bearing formation is not exposed in sea cliffs, and the croppings in the interior are not well defined.

EAST OF CAPE SABINE.

Croppings of half a dozen or more coal beds were seen south of a camp 10 miles east of Cape Sabine. One of these which was well exposed was found to be over 4 feet thick. The beds strike N. 80° E. and dip north from 20° to 40°.

CAPE BEAUFORT.

The occurrence of coal at Cape Beaufort, 40 miles east of Corwin Bluff, was noted by Mr. Collie[a] seventy-five years ago. At this point there is a hill 500 feet high, but the cliff is made up of Quaternary gravels, ground ice, and talus from the hill, so that there are no good natural exposures of the coal-bearing strata. In the hasty examination made by the writer the croppings of four coal beds were discovered on the hill, but no measurable exposures were found. Schrader,[b] who visited the locality in 1901, reported that he saw a partially developed coal bed 6 feet thick, one-eighth mile from the coast. The beds strike S. 45° E. and dip 20° SW.

WAINWRIGHT INLET.

The writer's examination of this coal field ended at Cape Beaufort, but its continuation to the north is inferred from coal found along the beach and dredged up from the sea floor.[c]

The most northerly occurrence yet reported of the coal along the coast is at Wainwright Inlet, latitude 70° 37′, longitude 159° 45′. Here it is said by Mr. Woolfe,[d] who discovered it in 1889, to occur on the banks of Kuk River, which flows into the inlet.

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[a] Zoology of Captain Beechey's voyage, London, Henry G. Bohn, 1839, p. 173.
[b] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S Geol. Survey No. 20, 1904, p. 110.
[c] Zoology of Captain Beechey's voyage, p. 174.
Dall, W. H., Coal and lignite in Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt., p. 1 820.
[d] Report on population and resources of Alaska: Eleventh Census, Washington, 1893, p. 133.

Schrader collected[a] fossil plants at Wainwright Inlet in 1901, which indicate that the Corwin formation is present there, and though he was unable to visit the locality mentioned by Woolfe he found samples of apparently good coal near the point where the fossils were collected. A sample collected by Schrader and analyzed by George Steiger was as follows:

Analysis of coal collected near Wainwright Inlet, Alaska.

	Per cent.
Fixed carbon	42.94
Volatile matter	42.99
Moisture	10.65
Ash	3.42
	100.00
Sulphur	.62
Coke	None.
Fuel ratio	.99

The analysis resembles that of the coal from the upper bed of the Corwin formation at Corwin Bluff.

INLAND EXTENSION.

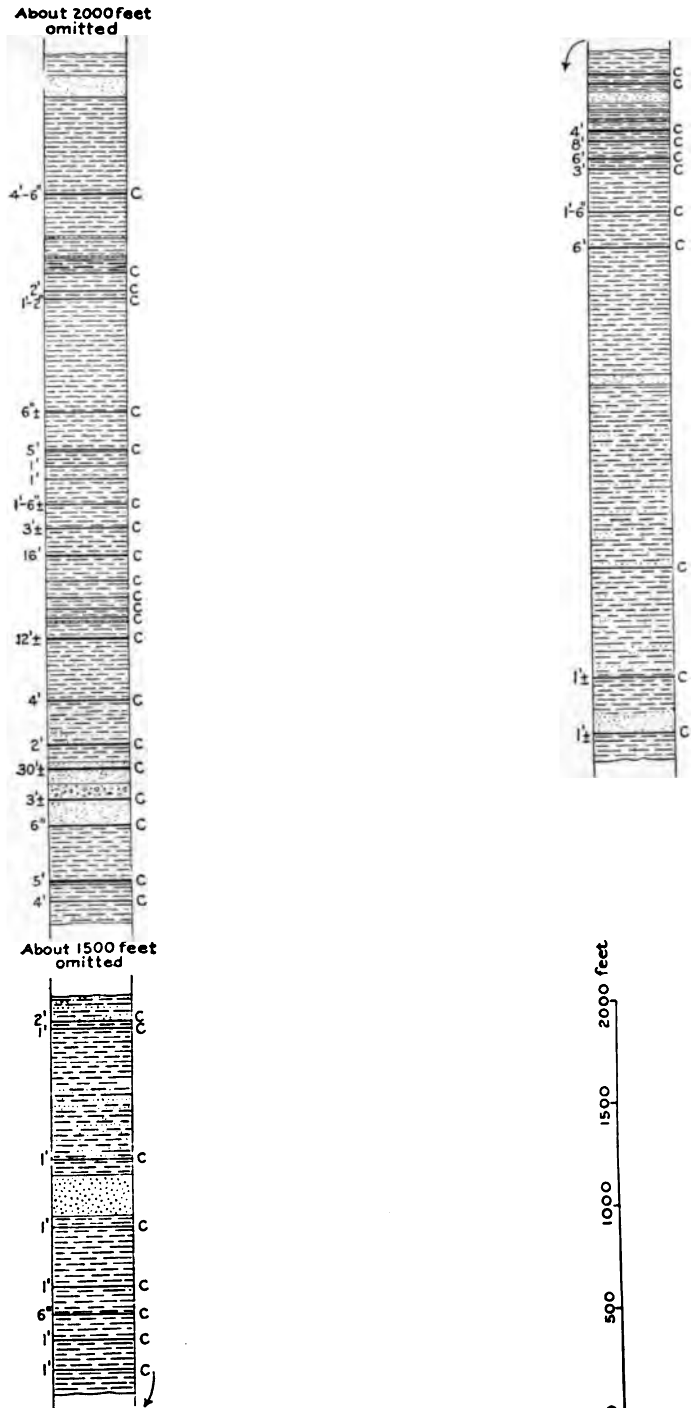
The present investigation was necessarily confined to a strip a few miles wide along the coast, but the inland extension of the coal field can be reasonably inferred from topographic evidence. Residents of the region who have made the trip from Point Hope to Cape Sabine by way of Kukpuk and Pitmegea rivers report that they found coal at their camp on the portage between these rivers. This camp could not have been less than 20 miles inland southeast of Cape Sabine. Coal has also been reported from the Colville, near its headwaters, by Ensign Howard[b] of the United States Navy, who discovered it in 1886, and by James S. Reed,[c] who visited that region in 1903. The topography of the upper Colville basin is reported to be undulating with low hills, the rocks consisting of a sandstone formation in which thick veins of bituminous coal outcrop along most of the creeks.

Howard makes the following statement in regard to the coal: "During the afternoon we passed a hill about 500 feet in elevation with outcrops of coal on the sides, and beyond the coal were found pieces of a substance called wood by the natives. It was hard, brittle, light brown in color, very light in weight, and burned readily, giving out quantities of gas. This material was scattered around in all shapes, sizes, and quantities." Dall[d] suggests that this material may be ozocerite, but no samples of it were brought away. Some material answering to this description was found on the headwaters of Kivalina River last summer by W. Thompson. It is a sort of brown "cannel" coal and burns readily, evolving much gas and flame. Some of the coal beds at Corwin Bluff are reported to contain cannel coal, though no samples were obtained.

Although the continuity of the Corwin coal-bearing formation to this point has not been demonstrated, it seems probable from the facts noted above that the coals of Colville River are of the same horizon as those on the coast.

The rocks of the Corwin formation were not recognized by Schrader along Anaktuvuk or lower Colville rivers, though a Lower Cretaceous formation called the Anaktuvuk series, which is not coal bearing, occurs on the river of that name.[e]

[a] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904. p. 110.
[b] Stoney, G. M., Naval explorations in Alaska, U. S. Naval Institute, Annapolis, 1900, p. 69.
[c] Schrader, F. C., op. cit., pp. 31 and 109.
[d] Coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 818.
[e] Schrader, F. C., op. cit., pp. 74-76.



COLUMNAR SECTION OF THE CORWIN FORMATION, SHOWING STRATIGRAPHIC POSITIONS OF VARIOUS COAL BEDS.

PALEOZOIC COAL FIELDS.

EXTENT.

The Paleozoic coals of the Cape Lisburne region are of Lower Carboniferous age and occur in the rocks of the Carboniferous series, which has been described under the heading "Geology." The coal-bearing member is apparently near the bottom of the series. Owing to the complicated structure of the rocks of the Lower Carboniferous series, the coal-bearing formation outcrops in limited areas, whose inland extensions and outlines can be determined only by more detailed work than the time allowed this expedition.

The coal-bearing member outcrops in several small areas near the coast south of Cape Lisburne, on Kukpuk River, about 15 miles from the coast, and on the coast at Cape Thompson. The coal beds were not reported by any of the early explorers, and they have not been worked to any extent by whalemen. They were first recognized as distinct from the Mesozoic coals by A. G. Maddren, who visited one of the localities in 1900.[a] Small amounts of the coal have been tested in galley stoves and a few tons have been mined for use at the Point Hope whaling station, but there have been no large amounts mined, nor have analyses been made previous to 1904.

It is said to give a more intense fire than Nanaimo coal, but engineers of the revenue cutter *Corwin* regarded it as too hard to burn in furnaces not provided with forced draft.

LOCALITIES IN DETAIL.

NIAK.

Four miles[b] south of Cape Lisburne black coal-bearing shales outcrop for about half a mile in a cliff about 50 feet high back of a narrow beach. The locality, a famous camping place of the natives, is called Niak, and is near the mouth of a large creek from which vessels have occasionally taken water. On the south side the shales are in contact with the massive limestones which are faulted over them (see fig. 5, page 20). The outcrop of the formation extends inland in a southeast direction, but its limits have not been determined. The shales are very much crumpled, and the inclosed coal beds are often sheared so that no continuous bed remains, but the coal occurs in lenticular masses along fault planes. Maddren reports seeing a 4 or 5 foot bed of coal whose outcrop extended across from the coast to the creek and which dipped north at an angle of 60°. Small amounts have been mined from the lenses noted above, and Mr. Washburne reports that he saw a pile of coal which was mined and sacked previous to 1904. A sample taken from these sacks was analyzed by W. T. Schaller with the following result:

Analysis of coal from Niak, 4 miles south of Cape Lisburne, Alaska.

	Per cent.
Fixed carbon	77.65
Volatile hydrocarbon	15.64
Moisture	3.77
Ash	2.94
	100.00
Coke	None.
Color of ash	Light gray.
Fuel ratio	4.97

CAPE LEWIS.

About 1 mile south of Cape Lewis, which is a promontory nearly 1,000 feet high 11 miles south of Cape Lisburne, there is a second exposure of coal-bearing shales

[a] Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, p. 113.
[b] This description is based on the work of C. Washburne. The locality was not visited by the writer.

which outcrop for half a mile in a low cliff back of the beach. These shales carry in addition to the coal abundant fossil plants of Paleozoic type. Beyond the short cliff no outcrops of coal have been observed, though there are occasional outcrops of black shale for 3 miles to Cape Dyer. The coal-bearing shales are overlain by thinly bedded limestones and black cherts and slates, which are in turn overlain by the massive limestones of Cape Lewis (see fig. 4, p. 19), and they appear to rest conformably on the massive sandstone of which Cape Dyer is composed.

The coal beds at this point have not been developed and have yielded no coal. Though only one bed of sufficient thickness to mine has been discovered, it is probable that a small amount of development would uncover several beds, some of which may be of sufficient size to work. Since the structure does not seem greatly complicated, the beds may be found to contain a considerable quantity of workable coal.

The outcrops which were examined are at a point about 1½ miles south of Cape Lewis. They are usually covered by talus from the cliff, but the locality can be easily recognized, since it is the first rock exposure south of a creek about 1 mile south of the cape.

The upper bed of coal strikes N. 75° E. and dips north at an angle of 40°. It is 4 feet thick, but is considerably crushed, and only fine material can be obtained from the croppings. The seam has one small indistinct parting near the middle. It could not be traced back from the coast on account of a heavy covering of chert and limestone débris. The roof of the coal bed is hard gray fire clay, and the underlying beds are hard black fire clays or slates containing fossil plant remains. Two smaller beds, which could not be measured, outcrop south of this at intervals of about 50 yards. Their overlying and underlying beds are similar to those of the bed described above. A sample was taken by the writer across the whole face of the 4-foot coal bed, which, when analyzed by W. T. Schaller, gave the following result:

Analysis of coal from beds 1 mile south of Cape Lewis, Alaska.

	Per cent.
Fixed carbon	70.33
Volatile hydrocarbon	21.16
Moisture	5.51
Ash	3.00
	100.00
Sulphur	.96
Coke	None.
Color of ash	Brown.

CAPE DYER.

A third area of these coal-bearing rocks reaches the coast south of Cape Dyer, and the coal beds are exposed in a low cliff, which is nearly continuous from Cape Dyer to the high bluff called "The Ears," a distance of about a mile and a half. An abandoned native settlement here bears the name Capaloa,[a] and the name is applied by the writer to the creek near which the old houses stand.

Cape Dyer is about 16 miles south of Cape Lisburne. Seen from the north it appears as an isolated butte standing out in the sea, the land back of it being much lower. The coal-bearing formation probably connects back of the high point with the above-mentioned area south of Cape Lewis.

The coal-bearing rocks consist of black shales and slates interbedded with limestone or hard, light-colored fire clay. At the north end of this exposure they overlie the massive sandstones of Cape Dyer with apparent conformity. At the south end the sandstones overlie the shales, the contact relation being a well-defined thrust fault. Where exposed in the cliff, the shales and interbedded limestones are very much

[a] According to Dr. John B. Driggs, missionary at Point Hope Capaloa is the native name for Cape Dyer as well as for the old village.

crumpled and often faulted, as is shown in fig. 3. S. J. Marsh reports that in 1900 a schooner on which he was a passenger obtained about a ton of coal here for use in the galley stove. There has been no development and there are no indications that the coals have been worked; moreover, development will be difficult and mining expensive on account of the disturbed condition of the beds. Coal beds outcrop at several places, but it is impossible to determine their number since some of them may be repeated. The largest bed seen measured 40 inches and dips to the south at an angle of 50°. The coal is more or less crushed and from the croppings only small pieces can be obtained. Only one of the other beds presented a measurable exposure; this is a bed 1 foot thick about three-fourths mile south of Cape Dyer. The coal from this bed was obtained in large pieces. A sample taken by the writer across the large bed gave the following analysis:

Analysis of coal collected 1 mile south of Cape Dyer, Alaska.

	Per cent.
Fixed carbon	79.86
Volatile hydrocarbon	15.62
Moisture	1.71
Ash	2.81
	100.00
Coke	None.
Color of ash	Light brown.
Fuel ratio	5.55

KUKPUK RIVER.

Coal beds probably of this formation outcrop on Kukpuk River, about 15 miles from its mouth. These have not been examined by the writer, though the occurrence here of the coal-bearing formation was observed. Specimens of cannel coal of good quality are found on the beach at the mouth of the river, which may have been washed down, though their source in the bed rock has not been found and they may have come from either the Mesozoic or Paleozoic formations. If coal should be developed on this river, Marryat Inlet could be used as a shipping point for small cargoes.

CAPE THOMPSON.

Similar coals have been reported from Cape Thompson about 40 miles south of Cape Lisburne. The Carboniferous rocks are known to extend to Cape Thompson, and the cliffs when seen from a distance appear to contain shales similar to those of the coal formation, but the locality has not been examined by the writer.

INLAND EXTENSION OF PALEOZOIC COALS.

Nothing is definitely known of the occurrence of Carboniferous rocks beyond a point 15 miles from the sea on Kukpuk River. From descriptions of Noatak River given by S. B. McLenigan [a] it seems possible that the crumpled shaly rocks of this series may be exposed at the canyon of the Noatak, which is about 120 miles east of Cape Thompson.

Carboniferous rocks correlated with the Lisburne formation were found by Schrader on the headwaters of John and Anaktuvuk rivers in 1901. No coal beds have been reported here, though it is possible that a more careful search may reveal the presence of the coal-bearing member. On upper John River in latitude 67° 7′ north, longitude 152° west, considerable coal detritus was observed. This was of such a quantity and character as to suggest the occurrence of bituminous coals of economic value somewhere in the region north of this locality and in the drainage basin of John River.

[a] Cruise of the *Corwin* in 1885. Washington, Government Printing Office, 1887, pp. 72-73.

CHARACTER OF CAPE LISBURNE COALS.

The coals of the Corwin formation which are most widely distributed in northwestern Alaska are of a rather low grade but considerably better than average lignite, though as a general rule they slack to a greater or less degree when exposed to the weather. They are all, so far as known, noncoking. The analyses made from samples collected from a number of beds in 1904 show that the average fuel ratio is about 1.22. The average percentage of water is below 10, and the average percentage of ash is about 5. The sulphur, wherever it has been determined, is less than half of 1 per cent. The average specific gravity, which has not been carefully determined, is probably between 1.30 and 1.40.

Mr. Chas. L. Norton, of the Massachusetts Institute of Technology, made the following report to the Corwin Trading Company on a sample of this coal:[a]

I find that the specimens of Alaska coal which you recently sent me have a calorific power of 7,560 calories per gram, or 13,600 B. T. U. per pound. This is quite as good as the average western coal and is not more than 10 per cent inferior to the best eastern coals. I can not guarantee the sampling of the coal, as I have had only a few small sample lots to work from. To guarantee the same I should have to select samples from several tons. I have made 28 combustions of the samples you sent me, and the figures given below are the average value.

Comparative values:	British thermal units.
New River	14,200
Alaska Corwin	13,600

No calorific tests have been made of the samples taken last summer though the proximate analyses which were made would seem to confirm the above results.

The coal when used for steaming purposes on the ocean has not given perfect satisfaction on account of its too small specific gravity for the high-draft steamer furnaces and its high percentage of ash. The coal which was sold at Nome was found satisfactory for domestic purposes, except for its high percentage of ash and clinkers. That a large part of this dissatisfaction can be overcome by greater care in mining or by washing the coal after mining is evident from the two analyses which were made of washed and unwashed coal from the large bed at Corwin Bluff (see table, page 38). In this case the ash was reduced by washing from 11 to 4 per cent.

The coals of the Carboniferous series are noncoking and of a grade between bituminous and anthracite which should probably be classed as semibituminous. The average of analyses of samples from three widely separated localities give: Fixed carbon 75 per cent, moisture 3.66 per cent, and ash 3.95 per cent. The average fuel ratio is 4.32. The only sample tested for sulphur gives 0.96 per cent. No tests for phosphorus have been made. None of the samples coked. These results indicate a very high-grade fuel containing very little refuse matter. The coal in all the beds sampled is considerably crushed and is usually in small pieces in the croppings, where it has probably been broken up to some extent, at least by freezing and thawing, but it does not slack perceptibly when exposed to the air. The specific gravity was roughly determined for two samples, and gave an average of 1.37.

ANALYSES OF COALS.

The samples for analysis obtained last summer represent as nearly as possible the whole thickness of the beds from which they were taken. They were sealed up immediately in tin tubes to prevent any loss of moisture, and the analyses in most cases, therefore, show a higher percentage of moisture than the analyses published heretofore of coals from the Cape Lisburne region. The table which follows includes several analyses that have been published before as well as those made from samples collected by the writer.

[a] Brooks, A. H., Coal resources of Alaska: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, p. 566. Schrader, F. C., Reconnaissance in northern Alaska: Prof. Paper U. S. Geol. Survey No. 20, 1904, p. 112.

A second table is inserted for the purpose of comparing these coals with coals from other parts of Alaska and the United States. With the exception of the analyses of Vancouver Island and Washington coals in this table the samples and analyses are from recent work of geologists and chemists of the United States Geological Survey and of the coal-testing plant maintained at the Louisiana Purchase Exposition,[a] and are as nearly as possible representative in every way of the mines from which they are taken.

No calorific determinations for the coals from the Cape Lisburne region have been made. By the use of an empirical formula which the writer has found to give approximately accurate results the average calorific value of the Jurassic coals can be estimated at 7,000 calories or 12,200 British thermal units, and of the Carboniferous coals 7,715 calories or 13,887 British thermal units. The calorific values of coals from the United States, obtained by this formula, differ only slightly from those determined experimentally, while the calculated calorific value of the British Columbia coals is nearly 500 calories higher than that given in the table.

Table of proximate analyses of coals from the Cape Lisburne region, Alaska.

Sample No.	Locality.	Fixed carbon.	Volatile hydrocarbon.	Moisture.	Ash.	Sulphur.	Fuel ratio.	Geologic formation.	Analyst.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		
4 A W 7....	1½ miles west of Corwin Bluff.	40.80	41.30	13.55	4.35	0.40	0.96	Corwin ...	W. T. Schaller.
4 A C 1	¾ mile west of Corwin Bluff.	42.06	37.72	11.18	9.04	......	1.11	.....do	Do.
4 A C 4	¼ mile west of Corwin Bluff (unwashed sample).	41.67	37.49	9.45	11.39	.30	1.11	.....do	Do.
4 A C 5	¼ mile west of Corwin Bluff (washed sample).	47.49	39.08	9.49	3.49	......	1.21	.....do	Do.
4 A C 6	Corwin Bluff.......	57.49	34.59	4.49	3.43	.39	1.63	.....do	Do.
4 A C 2	1,000 feet east of Corwin Bluff.	48.47	33.40	12.45	5.68	......	1.45	.....do	Do.
4 A W 20...	Thetis mine, 8 miles east of Corwin Bluff.	46.27	35.60	13.61	4.52	......	1.30	.....do	Do.
653 [b]	Near Wainwright Inlet.	42.94	42.99	10.65	3.42	.62	.99	.....do	George Steiger.
655 [b]	Cape Beaufort.....	51.23	36.38	7.18	5.21	.48	1.40	.....do	Do.
669 [b]	Corwin mines	46.16	40.12	10.47	3.25	.27	1.10	.....do	Do.
671 [b]	Corwin mines	50.05	38.68	7.23	4.04	.23	1.30	.....do	Do.
[c]...........	Corwin mines (?) ..	47.39	43.75	3.75	5.11	.36	1.08	(?)	Albert H. Welles.
	Average of coals from Corwin formation.	46.83	38.42	9.46	5.24	.38	1.21		
4 A W 42 ...	4 miles south of Cape Lisburne.	77.65	15.64	3.77	2.94	......	4.96	Carboniferous.	W. T. Schaller.
4 A C 24 ...	1 mile south of Cape Lewis.	70.33	21.16	5.51	3.00	.96	3.32	.....do	Do.
4 A C 31 ...	1 mile south of Cape Dyer.	79.86	15.62	1.71	2.81	......	5.11	.....do	Do.
	Average of coals from Lisburne formation.	75.94	17.47	3.66	2.92	......	4.46		

[a] Parker, E. W., Holmes, J. A., and Campbell, M. R., Preliminary report on the operations of the coal-testing plant: Bull. U. S. Geol. Survey No. 261, 1905.

[b] Schrader, F. C., Reconnaissance in northern Alaska in 1901: Prof. Paper U. S. Geol. Survey No. 20, 1904, p. 114.

[c] Brooks, A. H., Coal resources of Alaska: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, p. 565.

Comparison of analyses of coal from the Cape Lisburne region with coals from other parts of Alaska and the United States.

	Fixed carbon.	Volatile matter.	Moisture.	Ash.	Sulphur.	Fuel ratio.	Calories.
Average of 12 analyses of Jurassic coals from Cape Lisburne region	46.83	38.42	9.46	5.24	0.38	1.21	......
Average of 3 analyses of Carboniferous coals from Cape Lisburne region	75.94	17.47	3.66	2.92	.96	4.46	......
Average of 6 analyses of coal from Kachemak Bay, Alaska[a]	30.99	40.48	19.85	8.68	.35	.76	......
Average of 12 analyses of coal from Controller Bay, Alaska[b]	75.65	15.07	1.31	7.97	1.25	5.15	......
Average of 13 analyses of commercial coals from Vancouver Island[c]	55.72	31.57	1.54	10.24	.83	1.76	6,775
Average of 10 analyses of coal from the State of Washington[d]	56.01	31.60	4.43	7.45	....	1.45	......
Average of 12 analyses of coals from West Virginia[e]	63.94	27.63	2.25	6.17	1.09	2.31	7,982
Average of 6 analyses of coals from Illinois[e]	42.56	35.23	7.61	12.90	3.02	1.20	6,296
Average of 2 analyses of lignites from Texas[e]	23.41	36.49	30.72	9.38	.53	.64	4,181
Average of 2 analyses of lignites from North Dakota[e]	36.55	37.91	16.06	9.47	1.32	.96	5,153

[a] Stone, R. W., Kachemak Bay coal fields: Bull. U. S. Geol. Survey No. 277. (In preparation.)
[b] Martin, G. C., Progress report of the division of Alaskan mineral resources for 1904: Bull. U. S. Geol. Survey No. 259, 1905, p. 149.
[c] Annual report of the Minister of Mines, 1902. Victoria, B. C., Wolfenden, 1903, p. H-262.
[d] Smith, G. O., Coal fields of the Pacific Coast: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, p. 490.
[e] Parker, E. W., Holmes, J. A., and Campbell, M. R., Preliminary report of the operations of the coal-testing plant: Bull. U. S. Geol. Survey No. 261, 1905, pp. 32-59.

CONDITIONS OF MINING AND DEVELOPMENT.

There are no permanent developments or conveniences of mining at any of the places in the Cape Lisburne region where coal has been obtained. When the mines were operated by the whaling fleet the ships anchored near and sent sailors ashore to dig coal from the croppings wherever it was convenient. Sometimes powder was used to break down the face of the cliff, after which the coal could be picked out of the débris. In 1900 and 1901 the Arctic Development Company and the Corwin Trading Company attempted to mine a little more systematically, but as the work was largely done by Eskimos and directed by men inexperienced in coal mining, it is doubtful whether the product fairly indicated what the mines would produce if properly exploited. All black rocks were probably sacked up and sent on board.

Since 1900 a few white men remaining at Corwin Bluff have attempted to work the coal beds during the winter by short tunnels driven in from the face of the sea cliff, but the results have been unsatisfactory, since the entrances to the mines and the coal produced were covered by snowdrifts which turned to ice and made them inaccessible when the ships arrived in the summer.

The development of the coal beds at Corwin Bluff from some point back of the cliff would be easy on account of their perfect regularity, and there is no reason why mines developed in this way could not be worked all winter.

Coal mined and sacked in winter would be available for shipment in summer if piled on the level ground above the cliffs or at places near sea level where the cliffs are lower and snowdrifts do not form. There are two such places convenient to Corwin Bluff, with good beaches before them for landing. In fair weather coal could probably be loaded on vessels by means of a cable tramway from the top of the cliff, but the experience gained at Nome would seem to indicate that in the long run it would be less expensive to lighter it from the beaches. This work can probably be done more easily at Corwin Bluff than at Nome, because ships can anchor much nearer the shore.

During the summer months only calm days can be used for boating coal off to the ships. Strong north or northeast winds make landings impossible, and strong south winds also make the work difficult. During thirty days from July 22 to August 22, 1904, there were thirteen days during which the surf was too high for landing and several more when strong south winds would make the use of a line necessary.

The high-grade bituminous coals of the Carboniferous formation south of Cape Lisburne occur in limited areas and in rocks that are very intensely folded, so that the beds are irregular and the cost of mining will necessarily be greater than at Corwin Bluff. The character of the coal, however, will probably justify their development at some time in the future. The conditions for shipping coal are better than at Corwin Bluff, since vessels can find deep water nearer shore and the anchorage is sheltered from northeast winds by the Lisburne Hills. The force of the sea from south winds also is broken by the Point Hope peninsula. Should any of these deposits be developed enough to justify it, they could be connected by a short railroad with Marryat Inlet, a good harbor for small vessels, where wharves and bunkers can be maintained.

The coals from this region can not compete with outside coal at Nome since the latter is sold there as low as $15 per ton, which is less than the cost of shipping from the Cape Lisburne region. A limited amount of coal at either of the localities mentioned along the coast would probably find a ready sale to whaling ships and revenue cutters at not less than $10 per ton, and a larger amount could doubtless be disposed of in the mining camps about Kotzebue Sound. Coal from outside sources has probably never been sold at Kotzebue Sound for less than $30 per ton. The whole amount of coal which could be marketed from the Cape Lisburne region at present is probably between 500 and 1,000 tons annually.

SUMMARY OF ECONOMIC GEOLOGY.

The coals of the Cape Lisburne region are of two distinct classes—low-grade bituminous coal of Mesozoic age and high-grade bituminous or semibitumous coal of Paleozoic age.

The Mesozoic coal fields are known to cover an area of about 300 square miles, but reports obtained from prospectors and others indicate that their extent may be much greater. The coal-bearing formation is of great thickness and contains at least 150 feet of coal distributed in from 40 to 50 seams, no less than 10 of which are over 4 feet thick and seem to be suitable for mining. The geologic structure of the formation is simple and well adapted to mining, and the greatest obstacle will be the absence of timber in the region. The coal is a low grade of bituminous, but considerably better than lignite. Vessels of the whaling fleet and revenue cutters have for the last twenty-five years occasionally obtained a supply from the croppings of the seams in the sea cliffs near Corwin Bluff, and in 1900 and 1901 over 1,000 tons were mined and sold at Nome for $18 to $25 per ton in competition with Washington and British Columbia coals. It has not given as much satisfaction as that from Washington and British Columbia. Although it produces steam rapidly, it is not lasting and leaves too large a percentage of clinker and ash. This result is no doubt partly due to the unsystematic manner of mining from natural croppings in the cliffs, and if the beds were properly developed in depth and the coal carefully mined to exclude unnecessary refuse it would probably give fair results for steaming purposes. A limited amount of coal, if it could be relied on, at Corwin Bluff would find a ready sale to whalemen and vessels of the Revenue-Marine Service at not less than $10 delivered on the beach. At present these Mesozoic coals can not compete at Nome with those from the outside, but in the mining camps of the northern portion of Seward Peninsula, where outside coal rarely sells for less than $30 per ton, about 1,000 tons from Corwin Bluff could probably be easily disposed of. Should future development of

Alaska or of the commercial activities of the world create such a demand for coal of this character as to justify the building of a railroad to the region, the supply will probably be found sufficient for many years' use.

The Paleozoic coals of the region occur in limited areas and the beds are very much crumpled and broken. The largest bed seen is not over 4 feet thick, but the coal is of a high grade, suitable for special purposes, such as blacksmithing and metallurgy, and will probably compare favorably as a heat producer with any coal used on the Pacific coast. These coals are also undeveloped and on account of their complicated geologic structure they will be more difficult to mine than the Mesozoic coals. On the other hand, the anchorages south of Cape Lisburne are protected from northeast and south winds, and deep water can be found nearer shore than at Corwin Bluff. The localities are also convenient to Marryat Inlet, which is a good harbor for vessels of less than 10 feet draft. On account of their good quality these coals could probably be sold at a profit even in the Nome market, where the best outside coal still commands a price of $30 per ton. It is therefore safe to say that the Paleozoic coals of the Cape Lisburne region warrant investigation, and it is not unreasonable to expect that in the future their exploitation will contribute an appreciable addition to the value of the mineral output of Alaska.

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CLASSIFICATION OF THE PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Bulletin No. 278.]

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WRIGHT, F. E. and C. W. Mineral resources of the Wrangell and Ketchikan mining districts, Alaska.

TOPOGRAPHIC MAPS OF ALASKA.

The following maps are for sale at 5 cents a copy, or $3 per hundred:

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The following maps are included as illustrations of published reports, but have not been issued separately. They can be obtained only by securing the report.

Alaska, topographic map of; scale, 1:2500000. Preliminary edition. Contained in "The geography and geology of Alaska, a summary of existing knowledge, etc." Prof. Paper No. 45. R. U. Goode.

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Cook Inlet, head of, to the Tanana via Matanuska and Delta rivers, also part of Kenai Peninsula; scale, 1:625000. Contained in "A reconnaissance from Resurrection Bay to Tanana River, Alaska, in 1898." Twentieth Ann. Rept., pt. 7, 1900, pp. 265-340. W. C. Mendenhall.

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Fairbanks and Birch Creek districts, reconnaissance maps of; scale, 1:250000. Contained in "The gold placers of the Fortymile, Birch Creek, and Fairbanks regions." Bull. No. 251, 1905. T. G. Gerdine.

Fort Yukon to Kotzebue Sound, reconnaissance map of; scale, 1:625000. Contained in "Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska, by way of Dall, Kanuti, Allen, and Kowak rivers." Prof. Paper No. 10, 1902. D. L. Reaburn.

Koyukuk River to mouth of Colville River, including John River; scale, 1:625000. Contained in "A reconnaissance in northern Alaska across the Rocky Mountains, along Koyukuk, John, Anaktuvuk, and Colville rivers, and the Arctic coast to Cape Lisburne, in 1901." Prof. Paper No. 20. W. J. Peters.

Koyukuk and Chandlar rivers, portions of; scale, 1:625000. Contained in "Preliminary report of a reconnaissance along the Chandlar and Koyukuk rivers, Alaska, in 1899." Twenty-first Ann. Rept., pt. 2, 1900. T. G. Gerdine.

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O

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Series { A, Economic Geology, 67
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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

ECONOMIC GEOLOGY

OF THE

KITTANNING AND RURAL VALLEY QUADRANGLES, PENNSYLVANIA

BY

CHARLES BUTTS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1906

CONTENTS.

ILLUSTRATIONS.

ECONOMIC GEOLOGY OF THE KITTANNING AND RURAL VALLEY QUADRANGLES, PENNSYLVANIA.

By Charles Butts.

INTRODUCTION.

The field work upon which this bulletin is based was done in the autumn of 1901 and the summer and autumn of 1902 under the general supervision of Marius R. Campbell. The work in the Kittanning quadrangle was mainly done by Lester H. Woolsey and the writer in 1901, and that in the Rural Valley quadrangle almost wholly by the writer in 1902.

In addition to the data collected in the field much has been derived from published reports of the Second Geological Survey of Pennsylvania, particularly the reports of W. G. Platt on Armstrong County, I. C. White and H. M. Chance on Butler County, and John F. Carll on the oil regions. Many valuable well records have been furnished by the oil and gas companies operating in the region and by well contractors, and information pertaining to their properties has been given by the coal-mining companies, quarrymen, and those connected with the clay industries of the area. For all such material, which adds greatly to the value of this report, the author acknowledges his obligations.

TOPOGRAPHY.

LOCATION.

As will be seen on the key map (fig. 1), these quadrangles lie in central-western Pennsylvania and extend from latitude 41° on the north to 40° 45′ on the south, and from longitude

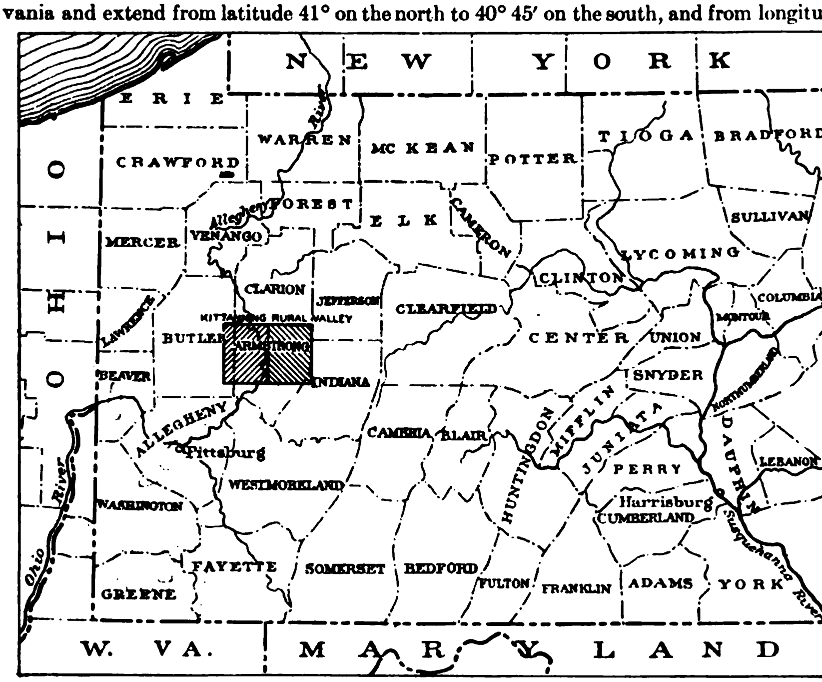

Fig. 1.—Key map showing location of the quadrangles.

79° 15′ on the east to 79° 45′ on the west. Each quadrangle includes one-sixteenth of a square degree, and their combined area is about 460 square miles. They lie almost wholly in Armstrong County, but the Kittanning quadrangle includes a narrow strip of Butler County and that portion of both quadrangles north of Redbank Creek lies in Clarion County. The quadrangles are named from the principal towns within their boundaries.

The latitude and longitude of the quadrangle boundaries have been determined from stations located on some of the prominent hilltops of the region. These stations have been connected by triangulation with astronomical stations at Washington, Cumberland, Grafton, and Pittsburg, and the accuracy of the work has been checked by a carefully measured base line on the Pennsylvania Railroad north of Latrobe.

TRIANGULATION STATIONS.

All surveys for the maps of this bulletin are based on six triangulation stations located within the quadrangles and six other stations in close proximity thereto. The locations of the stations within the quadrangles are shown on the topographic maps by small triangles, but the following sketch (fig. 2) shows the relative position of all these points. The stations are marked by stone posts 8 by 8 inches in cross section. In the center of the top of

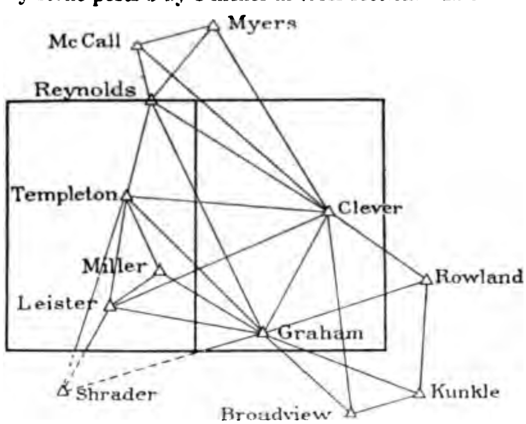

FIG. 2.—Sketch map showing location of triangulation stations on which the survey of the quadrangles is based.

each post is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania." For the convenience of engineers who may wish to secure accurate control over their surface surveys, the following list of stations, with full details regarding the angles by which their positions have been determined, is given.[a] There is also given a list of permanent and temporary bench marks, with their elevations, which were established in the course of the spirit leveling by which control over the surface relief of the quadrangle was secured.

STATIONS WITHIN THE QUADRANGLES.

CLEVER, ARMSTRONG COUNTY.

On a high cultivated ridge, with scattering dead trees, in Wayne Township, about 1 mile west of Belknap and 1 mile east of Snydersville (Muff post-office), on land belonging to G. H. Clever, of Belknap.

Station mark: A sandstone post 39 by 8 by 8 inches, set 27 inches in the ground, in center of top of which is cemented a bronze tablet marked "U. S. Geological Survey - Pennsylvania."

Reference marks: Live chestnut tree, magnetic bearing S. 84° E., 45½ feet distant. Dead chestnut tree, N. 4° E., 121 feet distant. Fence on line between properties of G. H. Clever and Jeremiah Bowser bears due south, 3 feet distant.

[a] The list has been compiled from Bull. U. S. Geol. Survey No. 181.

[Latitude 40° 53′ 35.63″. Longitude 79° 19 ′25.41″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Graham	29	26	30.0	117	12	06.0	4.0951985
Leister	65	59	54.4	209	22	57.3	4.1909592
Templeton	93	16	57.6	245	48	30.3	4.4288814
Reynolds	120	59	58.2	273	06	31.1	4.3508735
McCall	130	01	44.6	300	50	42.0	4.3643865
Myers	147	47	30.2	309	51	31.4	4.4550873
Rowland	297	06	56.5	327	41	28.6	4.3829142
Broadview	353	06	02.8	173	07	19.6	4.3608128

GRAHAM, ARMSTRONG COUNTY.

About 1 mile east of Blanket Hill post-office, on a bare ridge of cultivated land owned by the Graham heirs and rented by W. A. Blose.

Station mark: A sandstone post 36 by 8 by 8 inches, set 32 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

Reference marks: Chestnut tree 24 inches in diameter, magnetic bearing S. 23° W., distant 415 feet. Dead chestnut tree 18 inches in diameter, S. 86° W., distant 257 feet.

[Latitude, 40° 46′ 17.28″. Longitude, 79° 24′ 50.74″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Shrader	73	49	24.6	253	39	11.0	4.3613318
Leister	98	40	56.3	278	33	05.5	4.2328320
Miller	120	00	41.6	299	55	18.5	4.1263694
Templeton	135	00	42.7	314	53	49.7	4.3203059
Reynolds	154	18	20.5	334	12	37.9	4.4504542
Clever	209	22	57.3	29	26	30.0	4.1909592
Rowland	247	12	03.4	67	20	45.1	4.3072670
Kunkle	291	35	03.6	111	43	17.4	4.2810749
Broadview	311	40	54.2	131	45	43.1	4.1436489

LEISTER, ARMSTRONG COUNTY.

Six miles southwest of Kittanning, in North Buffalo Township, on a round knob, cleared on southeast side and timbered on northwest side. The land belongs to Sarah Jane Gray, of McHaddon.

Station mark: A sandstone post 40 by 8 by 8 inches, set 35 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

Reference mark: Oak tree 18 inches in diameter, magnetic bearing N. 30° W., 77½ feet distant.

[Latitude, 40° 47′ 40.31″. Longitude, 79° 36′ 51.50″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Shrader	29	48	10.1	209	45	46.8	4.0155564
Templeton	189	42	25.0	9	43	23.3	4.0930300
Miller	232	08	42.0	52	11	10.0	3.8272558
Clever	245	48	30.3	65	59	54.4	4.4288814
Graham	278	33	05.5	98	40	56.3	4.2328320

MILLER, ARMSTRONG COUNTY.

In East Franklin Township, about 2 miles northwest of Kittanning, on a flat, cultivated hill owned by James Miller. It is 100 yards west of his brick house.

Station mark: A stone post 36 by 8 by 8 inches, set 34 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

[Latitude, 40° 49′ 53.90″. Longitude, 79° 33′ 05.12″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Leister	52	11	10.0	232	08	42.0	3.8272558
Templeton	158	21	39.5	338	20	09.8	3.9397410
Graham	299	55	18.5	120	00	41.6	4.1263694

TEMPLETON, ARMSTRONG COUNTY.

About 1½ miles north of Middlesex (Cowansville post-office), in Sugar Creek Township, on a bare ridge with timber on the northwest side. The land is owned by Widow Templeton.

Station mark: A sandstone post 42 by 8 by 8 inches, set 30 inches in the ground, in the center of the top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

Reference mark: A wild cherry tree, 7 inches in diameter, magnetic bearing N. 8° W., 164 feet distant.

[Latitude, 40° 54′ 16.17″. Longitude, 79° 35′ 22.26″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Leister	9	43	23.3	189	42	25.0	4.0930300
Shrader	18	52	03.4	198	48	43.8	4.3503890
Reynolds	193	21	32.2	13	22	43.0	4.0389218
Clever	273	06	31.1	93	16	57.6	4.3508735
Graham	314	53	49.7	135	00	42.7	4.3203059
Miller	338	20	09.8	158	21	39.5	3.9397410

STATIONS WITHOUT THE QUADRANGLE.

BROADVIEW, INDIANA COUNTY.

About 2½ miles north of Shelocta and three-tenths mile east of Armstrong-Indiana County line, on a high, bare hill, with some timber on the southwest slope. The land is owned by John Russell.

Station mark: A stone post 42 by 8 by 8 inches, set 38 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

[Latitude, 40° 41′ 16.95″. Longitude, 79° 17′ 28.00″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Graham	131	45	43.1	311	40	54.2	4.1436489
Clever	173	07	19.6	353	06	02.8	4.3608128
Kunkle	253	14	15.6	73	17	40.3	3.8862700

KUNKLE, INDIANA COUNTY.

On land owned by Philip Kunkle, about 2 miles north of Creekside post-office, near western end of a high ridge having scattering trees on the eastern end.

Station mark: A stone post 42 by 6 by 6 inches, set 36 inches in the ground on solid rock, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

[Latitude, 40° 42′ 28.78″. Longitude, 79° 12′ 14.09″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Broadview	73	17	40.3	253	14	15.6	3.8862700
Graham	111	43	17.4	291	35	03.6	4.2810749
Rowland	183	45	23.0	3	45	50.3	4.1737351

MYERS, CLARION COUNTY.

About 3 miles southeast of Sligo, in Toby Township, near the main road between Clarion and East Brady, and about halfway between the two places, on a bare knob of cultivated land belonging to V. R. Myers, of Sligo.

Station mark: A sandstone post 36 by 8 by 8 inches, set 30 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

Reference marks: Chestnut tree, magnetic bearing S. 65° E., 303 feet distant. Chestnut tree S. 55° W., 115 feet distant. Chestnut tree N. 84° W., 203 feet distant.

[Latitude, 41° 04′ 37.67″. Longitude, 79° 28′ 36.80″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Reynolds	39	10	40.8	219	07	25.6	4.0414047
McCall	76	45	26.6	256	41	14.5	3.9639954
Clever	327	41	28.6	147	47	30.2	4.3829142

M'CALL, CLARION COUNTY.

On a bare flat knob about 1½ miles north of Bela post-office, 8 feet north of an east and west fence on land belonging to William T. McCall.

Station mark: A sandstone post 36 by 8 by 8 inches, set 32 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

Reference marks: Chestnut tree 18 inches in diameter, magnetic bearing N. 85° W., 185 feet distant. Chestnut tree 18 inches in diameter, S. 81° E.

[Latitude, 41° 03′ 29.14″. Longitude, 79° 35′ 00.49″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Myers	256	41	14.5	76	45	26.6	3.9639954
Clever	309	51	31.4	130	01	44.6	4.4550873
Reynolds	342	32	21.0	162	33	17.7	3.8277738

REYNOLDS, CLARION COUNTY.

On a round bare knob about 4½ miles northeast of East Brady on road to Rimersburg. The land belongs to the heirs of Alex. Reynolds, of Kittanning, and is occupied by George Leonard.

Station mark: A sandstone post 36 by 10 by 10 inches, set 33 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

Reference marks: Chestnut tree with broken top, magnetic bearing S. 58° W., 98 feet distant. Wild cherry tree, 4 inches in diameter, N. 73° W., 51 feet distant.

[Latitude, 42° 00′ 01.14″. Longitude, 79° 33′ 34.13.″]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Templeton	13	22	43.0	193	21	32.2	4.0380218
McCall	162	33	17.7	342	32	21.0	3.8277738
Myers	219	07	25.6	39	10	40.8	4.0414047
Clever	300	50	42.0	120	59	58.2	4.3643865
Graham	334	12	37.9	154	18	20.5	4.4504542

ROWLAND, INDIANA COUNTY.

On a high hill about 4 miles north of Plumville, in North Mahoning Township, and near the line between North and South Mahoning townships. On land owned by W. S. Rowland.

Station mark: A stone post 40 by 6 by 6 inches, set 36 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

[Latitude, 30° 50′ 31.39″. Longitude, 79° 11′ 32.36″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Kunkle	3	45	50.3	183	45	23.0	4.1737361
Graham	67	20	45.1	247	12	03.4	4.3072670
Clever	117	12	06.0	297	06	56.5	4.0951985

SHRADER, ARMSTRONG COUNTY.

(Not occupied.)

On a bare ridge in South Buffalo Township, 3 miles northeast of Freeport, on land owned by A. C. Shrader, of Freeport.

Station mark: A sandstone post 40 by 8 by 8 inches, set 36 inches in the ground, in the center of top of which is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania."

[Latitude, 40° 42′ 48.68″. Longitude, 79° 40′ 30.96″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Templeton	198	48	43.8	18	52	03.4	4.3503890
Leister	209	45	46.8	29	48	10.1	4.0155564
Graham	253	39	11.0	73	49	24.6	4.3613318

SPIRIT LEVELS.

All bench marks set in the course of this work were stamped with the word "PITTSBURG" and the date "1899," in addition to the figure of elevation, thus referring them to the central datum tablet for this group of levels, which is set in the foundation of the Seventh Avenue Hotel in Pittsburg, the adjusted elevation of which is accepted as being 738.527[a] feet above mean sea level at Sandy Hook. This elevation comes through five lines of precise levels, namely, through United States Coast and Geodetic Survey levels from Sandy Hook and from Old Point Comfort to Hagerstown and Grafton; through United States Coast and Geodetic Survey and United States Army Engineers levels from Dobbs Ferry to Albany, and from Albany via Oswego and the lakes to Erie; through United States Geological Survey levels from Albany to Dunkirk; and through Pennsylvania Railroad precise levels from Sandy Hook via Harrisburg to Pittsburg.[b]

Determined points in the Kittanning quadrangle.

	Feet.
East Brady; bronze tablet set in east abutment wing wall of steel highway bridge, marked "PITTSBURG 852, 1899"	852.645
Phillipston; top of stone milepost front of station, marked "P. 66, O. C. 66-$\frac{5}{10}$"	853.5
Phillipston, 2 miles south of; top of stone milepost, marked "P. 64, O. C. 68-$\frac{5}{10}$"	849.2
Redbank; top of west rail front of station	846.3
Redbank; bronze tablet set in north abutment of Allegheny Valley Railway bridge, 600 feet south of station, west side of abutment, marked "PITTSBURG 844, 1899"	844.746
Redbank, 13 miles south of; top of stone milepost, marked "P. 62, O. C. 70-$\frac{5}{10}$"	843.4
Riverview; top of rail, front of station	835.5
Rimer; top of west rail, front of station	832.3
Rimer, 0.5 mile south of; top of stone milepost, marked "P. 59 and O. C. 73-$\frac{5}{10}$"	831.7

[a] Readjusted elevation is 738.383.
[b] Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 1, 1900, p. 420.

	Feet.
Rimer, 2 miles southeast of; bronze tablet set in north abutment west side of iron bridge, marked "PITTSBURG 820, 1899" [a]	820.810
Rimer, 3.5 miles south of; top of stone milepost, marked "P. 56 and O. C. 76-$\frac{3}{10}$"	824.0
Rimer, 3.8 miles south of; top east rail at railroad crossing	821.6
Mahoning; top of east rail front of station	818.9
Templeton; top of west rail front of station	819.2
Templeton, 0.6 mile south of; top of west rail at railroad crossing	818.4
Templeton, 1.9 miles south of; top of west rail at railroad crossing	813.8
Templeton, 1.6 miles south of; top of west rail at railroad crossing	814.8
Templeton, 2.4 miles south of; top of west rail at railroad crossing	814.0
Templeton, 2.7 miles south of; top of stone milepost, marked "P. 51 and O. C. 81.5"	815.5
Mosgrove; bronze tablet set in north abutment east end of railroad bridge, 900 feet north of station, marked "PITTSBURG 806, 1899"	807.227
Mosgrove, 0.6 mile south of; top of stone milepost, marked "P. 49, O. C. 83-$\frac{5}{10}$"	807.9
Cowanshannock; top of east rail front of station	805.5
Cowanshannock, 1.5 miles south of; top of stone milepost, marked "P. 46, O. C. 86-$\frac{5}{10}$"	807.6
Neal; top of west rail on last crossing south of station	805.4
Wick City; top of west rail at crossing at pottery works	805.4
Kittanning; top of east rail front of station	806.5
Kittanning; bronze tablet set on front face northwest corner of public school on corner of McKain and Vine streets, marked "PITTSBURG 803, 1899"	803.500
Garrett Run; top of west rail front of station	796.2
Manorville; top of east rail front of station	796.1
Graff; top of west rail front of station	790.5
Ford City; top of east rail front of station	784.9
Ford City, 0.5 mile south of; top of stone milepost, marked "P. 40, O. C."	784.7
Rosston; top of west rail front of station	786.7
Rosston, 0.2 mile south of; bronze tablet set in east abutment of bridge over river, marked "PITTSBURG 786, 1899"	786.940

Kittanning along highway west to West Winfield, thence north to Chicora and east to East Brady. [b]

	Feet.
Weskit; in hay-scales platform, nail	1,037.2
McHaddon; in front of post-office, ground	1,335.0
West Winfield; 100 feet west of railroad tracks, in foundation of trestle, aluminum tablet marked "950 PGH 1900"	949.940
Fenelton; 375 feet west of station, in foundation of water tank, aluminum tablet marked "1068 PGH 1900"	1,068.572
Chicora; corner of Main street and Central avenue, directly opposite Union Hall, in sandstone post, aluminum tablet marked "1,246 PGH 1900"	1,245.543
Chicora, 6.5 miles northeast of; at intersection of Somerville road, old stone house, on window sill, chisel-mark projection	985.73
Rocketts Bridge; bridge floor	972.0
Bradys Bend; bridge below bend, floor	925.0

Determined points in the Rural Valley quadrangle.

	Feet.
Kittanning, 1 mile east of; north side of road, nail in stump	999.42
Kittanning, 2 miles east of; south side of road, rock, chiseled mark	1,145.55
Kittanning, 3 miles east of; south side of road, rock, chiseled mark	959.07
Kittanning, 3.33 miles east of; south side of road, pipe line, marked	988.00
Kittanning, 3.75 miles east of; at road south; rock, chiseled mark	985.65
Kittanning, 4.5 miles east of; 50 feet east of road northeast, north side of road, rock, chiseled mark "1026"	1,026.19
Stone House Hotel, 0.75 mile west of; east side of road, rock, chiseled mark	1,049.50
Kittanning, 6 miles east of; Stone House Hotel, in southeast corner stone, aluminum tablet, marked "1011 PITTSBURG"	1,010.491
Stone House Hotel, 1 mile east of; bridge, south side of road by rock, chiseled mark	1,022.74
Stone House Hotel, 1.5 miles east of; at road, chiseled mark "1116"	1,115.41
Stone House Hotel, 2 miles east of; south side of road by small wooden bridge, rock, chiseled mark	1,069.97
Yatesboro; railroad at west end of, top of rail	1,120.7
Yatesboro; railroad crossing in; top of rail	1,129.3

[a] This is bench mark 821 of Rural Valley sheet.
[b] Unpublished data; the error distributed in this line is excessive.

	Feet.
Yatesboro, 0.5 mile east of; south side of road, chiseled mark	1,123.94
Rural Valley; bridge in, southeast wing wall of, in coping stone, copper tablet, marked "1112 PITTSBURG"	1,111.610
Rural Valley, 3 miles north of; 600 feet south of schoolhouse, rock, chiseled mark	1,185.25
Dayton, 2.75 miles southwest of; west side of road, rock, chiseled mark	1,399.03
Rural Valley, 8 miles north of; at road to west, nail in root of oak tree	1,275.52
Dayton, 1.5 miles west of; Buffalo, Rochester and Pittsburg Railroad overhead bridge, on southeast, top of coping stone, chiseled mark	1,275.47
Dayton, 0.5 mile west of; road crossing, top of north rail at	1,322.5
Dayton, 0.25 mile west of; road crossing, top of south rail at	1,327.9
Dayton; 900 feet west of station, Buffalo, Rochester and Pittsburg Railroad bridge over small stream, northwest wing wall of, on second coping stone, aluminum tablet, marked "1326 PITTSBURG"	1,326.118
Eddyville, 2.5 miles south of; at crossroad, rock, chiseled mark	1,256.90
Eddyville, 2 miles south of; iron bridge over Mahoning Creek, on southeast abutment, chiseled mark "1019"	1,018.69
Eddyville, 1.5 miles south of; east side of road, rock, chiseled mark	1,200.53
Eddyville; iron bridge over Big Mahoning, on bridge seat, southeast wing wall, aluminum tablet, marked "992 PITTSBURG"	992.284
Eddyville, 0.25 mile northeast of; iron bridge over Pine Run, floor of	999
Putneyville, 1 mile east of; bridge over Sugar Camp Run, floor of	954
Putneyville; iron bridge over Mahoning Creek, northwest wing wall, coping stone, chiseled mark	940.42
Putneyville, 1.5 miles west of; north side of road, under oak tree, rock; chiseled mark	908.01
Putneyville, 3 (2½) miles west of; at cross rails, summit, rock, chiseled mark	1,027.82
Macks Bridge (over Mahoning Creek, 6 miles east of Mahoning), 0.5 mile east of; south side of road, rock, chiseled mark (1001 on map)	942.55
Mahoning, 6 miles east of; iron bridge over Mahoning Creek known as Macks Bridge; on southeast bridge seat, chiseled mark	863.50
Mahoning, 4 miles east of; opposite mill by road north, nail in root of tree	841.61
Mahoning, 2 miles east of; iron bridge, southwest wing wall, coping stone, chiseled mark	833.17
Mahoning; Allegheny Valley Railroad, opposite station, top of rail	818.7
Rimer 2 miles southeast of; railroad bridge, northwest abutment, bronze tablet, marked "PITTSBURG 820, 1899"	820.810

DRAINAGE.

The streams that drain a region exercise an important influence upon its economic development. Their valleys afford sites for the location of towns and open a way to communication with the surrounding country, either by water or rail. Along the valleys the strata are exposed and the beds containing valuable minerals are made accessible. The area discussed in this report has been particularly well favored in these respects. Allegheny River has cut a deep valley from north to south through the middle of the region, and this facilitates the exportation of its various mineral and manufactured products. East of the river and along the northern side of the quadrangles the valley of Redbank Creek affords passage to a railroad and exposes valuable beds of coal, clay, and limestone. Farther south Mahoning Creek, with its tributaries, Scrubgrass, Little Mudlick, and Pine creeks, likewise makes accessible the mineral deposits of a wide strip of territory extending to the eastern limit of the Rural Valley quadrangle. Still farther south the edges of the coal and limestone beds are exposed by both forks of Pine Creek, along the south fork of which runs the Buffalo, Rochester and Pittsburg Railroad, another important artery of communication with the outside world. Cowanshannock Creek and Garrett Run make accessible the coals of a large tract of country. North Branch of Plum Creek opens a way into the southeastern corner of the region. West of the river Buffalo Creek and Glade Run are the most important streams. The former is followed along the upper part of its course by the Buffalo, Rochester and Pittsburg Railroad and along the lower part by the Winfield Railroad, which reaches the quarries and brick works at West Winfield. All the important coal beds of the region are exposed along the valley of Glade Run from the Lower Kittanning, which outcrops at its mouth, to the Upper Freeport, which outcrops on the hillsides from its mouth to its source. Huling Run, Sugar Creek with its tributaries, and Little Beaver Run make accessible a considerable territory in the northern part of the Kittanning quadrangle.

RELIEF.

The surface of the region is hilly, but the upland slopes are generally moderate and easily cultivated. The valleys are narrow and the streams have developed very scanty flood plains. Occasionally farming land occurs in these valleys, but frequently the bluffs reach the water's edge and there is no level land. The walls of the larger valleys are almost invariably steep and in places precipitous; in others they are strewn with large bowlders, and, being thus ill suited to cultivation, they are generally forested. The upper courses of the minor streams are not so deeply trenched, and they are often bordered by rather gently sloping and arable land. Farming is necessarily confined almost exclusively to the uplands, and the stranger traveling along the valleys would little suspect the presence of well-cultivated fields just over the brows of the bluffs that restrict the range of his vision.

GEOLOGY.

STRUCTURE.

GENERAL STATEMENT.

The rocks of these quadrangles were originally deposited as sediments in an approximately horizontal position at the bottom of the sea or other bodies of water. Subsequently the rocks were elevated to their present position, and the strata were thrown into low folds forming anticlines and synclines.

METHOD OF REPRESENTING STRUCTURE.

The geologic structure of this region is represented on the map by means of contours. These are lines imagined to be drawn at regular vertical intervals upon the top of the Vanport ("Ferriferous") limestone as a reference surface through points having the same elevation above sea level. Many such points are determined, and lines are drawn connecting them. The contour interval is 50 feet; that is to say, for example, a line is drawn connecting all points of the reference surface 1,000 feet above the sea, and the adjacent lines are drawn through points at 950 and 1,050 feet above the sea, and so on.

In many cases the altitude of the points on the limestone is determined by direct observation on the outcrop; in others it is determined by borings that penetrate the limestone; in still others the elevation of some other stratum is observed, and the elevation of the limestone is calculated from the known interval between the two strata.

These contours are greatly generalized and only approximate. There are several sources of error affecting their determination. All observations are based upon the topographic map, and while there are many bench marks determined by lines of precise leveling by which observations may be checked, observations at other points may be based upon a local datum that is possibly out by several feet. Again, nearly all elevations, as those of outcrops or of well mouths, are determined by aneroid barometer, and such determinations are always liable to errors of greater or less extent. The probable failure in many cases to measure accurately the depth of the limestone in deep wells is another source of error. Still another is the variation in the thickness of the intervening rocks in those cases where the elevation of the limestone is calculated from observations on other strata. In so far as the actual interval between the observed stratum and the limestone differs from that at the nearest point of measurement, which interval is assumed at the point of observation, the determination of the altitude of the limestone at that point will be erroneous.

Notwithstanding these sources of error, it is believed that the actual altitude of the limestone will not differ more than a contour interval from that shown by the contours at any point, and that the structure as represented on the map closely approximates the truth. This method of representing structure has the advantage that it is possible by it to show the lay of the rocks over all parts of the area contoured. The position, form, and extent of the anticlines and synclines, the dip of the rocks, and the absolute altitude of the reference surface are readily delineated.

The great advantage of having the structure so completely shown is that it becomes possible to determine the approximate depth of any stratum, such as a coal seam, provided that the interval between the limestone and the given stratum is known at any point. This can be done as follows: Determine by the surface contours the elevation of the given point and by the structure contours the elevation of the Vanport limestone at that point; the difference between the two elevations will be the depth of the limestone below the surface, or, in case the limestone has been eroded, the elevation of its horizon. To the number thus obtained add the interval if the given stratum is below the limestone, or from that number subtract the interval if the given stratum is above the limestone. If the depth to a stratum is required at a point where the limestone has been eroded, subtract from the given interval the difference in elevation between the surface and the horizon of the limestone at the point. The determination of such facts should be of great benefit to prospectors in sinking diamond-drill holes and to mining companies in enabling them to determine the most advantageous locations of shafts and openings and to estimate the probable cost of drilling or of sinking shafts. It should also be of value to drillers for gas and oil who wish to locate their wells with regard to the structure, since it seems probable that the greater accumulations of these substances occur on and adjacent to the anticlines. From the intervals given in the discussion of the oil and gas sands, it will be possible to determine by the method already described the approximate depth to any gas or oil sand at any point in the quadrangles.

FORMER VIEWS OF STRUCTURE.

It seems well to preface the detailed description of the structure by an outline of the same as made out by previous surveys, and particularly by the Second Geological Survey of Pennsylvania. Platt[a] described in this territory a number of anticlines and synclines lying in regular order from northwest to southeast, as follows:

The Millerstown anticline, near the northwest corner; the Bradys Bend syncline, passing through Bradys Bend; the Bradys Bend anticline, passing near the mouth of Redbank Creek; the Lawsonham syncline, passing through Lawsonham, the Kellersburg anticline, passing through Kellersburg; the Stewartson Furnace anticline, a short axis in the vicinity of Dee; the Centerville syncline; the Anthonys Bend anticline, passing through Anthonys Bend, Redbank Creek; the Fairmount syncline, passing through Fairmount on Redbank Creek north of the quadrangles; the Greendale anticline, passing through Greendale; the Brookville anticline, at the head of Little Mudlick Creek; the Leechburg syncline; the Glade Run anticline, following Glade Run south of Mahoning Creek; the Apollo syncline, passing near Rural Valley; and the Port Barnet anticline, in the vicinity of Smeltzer. The axes of the anticlines and synclines are described and mapped as following straight courses about N. 30° E. Chance[b] differs from Platt in his description of the structure in the northwest corner of the Kittanning quadrangle. He describes the Millerstown as a short anticline lying southeast of Chicora, but not extending to the northeast beyond Donegal Township. Apparently what Platt describes as the Millerstown anticline, lying a little beyond the northwest corner of the quadrangles, is the same as Chance's Martinsburg anticline.

The results of the present survey, as far as regards structure, differ materially from those outlined above. The structure of the region will be described in detail, proceeding in regular order from northwest to southeast.

NORTHWEST CORNER OF THE KITTANNING QUADRANGLE.

The structure here is not pronounced, and its determination is based almost wholly upon the position of the Vanport ("Ferriferous") limestone as given in many well records. A low syncline apparently passes through Chicora to Karns and connects by a broad, shallow depression around the northeast end of the Millerstown anticline with the Bradys

[a] Platt, W. G., Second Geol. Survey Pennsylvania, Rept. H5, pp. xxxviii-xlvi, and maps, p. xxvi.
[b] Chance, H. M., Second Geol. Survey Pennsylvania, Rept. V, p. 10.

Bend syncline in the northwest corner of Sugar Creek Township. From the syncline through Chicora and Karns the strata rise gently northwestward to the Martinsburg anticline. The point of an anticline enters the northern part of Bradys Bend Township and extends southwestward into the southeast corner of Fairview Township. No name has been applied to either syncline or anticline, since little is known of them outside of the quadrangle.

MILLERSTOWN ANTICLINE.

The determination of the position and extent of this anticline by the present survey agrees fully with the description given by Chance.[a] Its axis crosses Buffalo Run about 2 miles southeast of Chicora and runs about N. 40° W. As shown in a number of wells, the elevation of the limestone on the axis is about 1,050 feet near the margin of the quadrangle. That the rocks dip slightly from this locality toward Chicora is proved by the facts that the Upper Freeport coal at that place is 1,260 feet above sea and that in the northwest corner of the Kittanning quadrangle the limestone is about 260 feet below the coal, which makes the elevation of the limestone at Chicora 1,000 feet. The regular dip of the rocks to the northeast and southeast toward the Bradys Bend syncline is shown by the position of the Vanport limestone in many wells along the axis of the syncline. The Millerstown anticline is separated from the point of the anticline to the north in Bradys Bend Township by the shallow depression connecting the Bradys Bend syncline and the shallow syncline at Chicora, as shown in many wells by elevations on the limestone of 1,000 feet or a little less.

BRADYS BEND SYNCLINE.

Platt described the axis of this syncline as crossing the boundary between Butler and Armstrong counties on Buffalo Creek and extending in a straight line northeast through Bradys Bend, but evidence now in hand shows that this axis lies west of the position thus assigned to it. Many oil wells on the Riley and Hickey farms northwest of Fenelton show the limestone to be about 900 feet above the sea. From these localities the limestone rises regularly northwestward, as shown by many wells, to the axis of the Millerstown anticline. In the southeast corner of Donegal Township, on the Goldlinger and Maley farms, about 1½ miles east of the Hickey wells, three wells give the elevation of the limestone at 1,050 feet. The axis of the syncline, then, lies west of the latter locality, probably in the vicinity of the Hickey farm. Another line of evidence also leads to the conclusion that the axis lies considerably west of Platt's location. The Upper Freeport coal is near water level on the western margin of the quadrangle. It can be traced down Little Buffalo Run, rising constantly southeastward; half a mile west of Fenelton it is more than 100 feet above the stream. About a mile southeast of Fenelton the Lower Kittanning coal lies 40 to 50 feet above the creek, and at Nichola the Vanport limestone is about 50 feet above the creek. These facts show conclusively that the rocks are rising eastward along Buffalo Creek from the western margin of the quadrangle, and that the axis of the Bradys Bend syncline enters the quadrangle from the southwest about 1 mile southwest of Fenelton, passing thence, as shown by numerous well records, in a nearly straight line one-half mile west of Rattigan and entering Armstrong County in the northwest corner of Sugar Creek Township, in the neighborhood of the Pontius and Reep farms, where the elevation of the limestone is 1,000 feet above sea. In the vicinity of Adams well records show the elevation of the limestone to be about 1,100 feet and the stratigraphic evidence points to a regular rise of the rocks toward that place from the northwest corner of Sugar Creek Township. From Adams the axis bends sharply eastward and passes through East Brady, as is shown by the fact that the limestone at a number of points near the mouths of Holder and Snyders runs has an altitude of from 1,020 to 1,030 feet. From this locality it rises on the north to 1,060 feet at the mouth of Pine Run, 1,110 feet one-half mile up Pine Run, and 1,100 feet one-half mile north of the village

[a] Second Geol. Survey Pennsylvania, Rept. V, p. 10

of Bradys Bend, just off the quadrangle; on the south it rises to 1,065 feet in the apex of the river bend 1 mile below East Brady. Farther down the river, one-half mile west of Phillipston, two points on the limestone were noted at 1,025 and 1,020 feet. This indicates a transverse wrinkle in the syncline running from East Brady toward Phillipston, which may have influenced Platt in locating the axis at the latter point. From this locality southeastward numerous observations on the limestone and other beds show a constant rise toward the Kellersburg anticline. About one-half mile northeast of Phillipston the elevation of the limestone was determined, from an observation on the Lower Kittanning coal, to be 1,075 feet. Almost due north of this point on the bluff of the Allegheny the altitude of the limestone is 1,055 feet. Still west and north nearly one-half mile the limestone lies at 1,075 feet. On the north side of the river, north of East Brady and just off the quadrangle, the elevation is 1,095 feet, and in the bluff on the east side of the river just south of the margin of the quadrangle the limestone is at 1,100 feet above sea. These observations locate the axis definitely along the neck between the bends of the river east of Bradys Bend. From this point eastward the position of the axis is more obscure. Near the head of a ravine entering Redbank Creek about a mile above its mouth old ore pits and presumably the limestone occur at an elevation of 1,100 feet. This point is about a mile north of the mouth of the creek. North of this the limestone was not seen, but the Lower Kittanning coal could be traced for some distance, rising perceptibly. Southward the strata also rise and the limestone was observed north of the mouth of Redbank Creek at 1,160 feet, while 1 mile up the creek it has an elevation of 1,200 feet. Still farther east the limestone was observed at 1,150 feet three-fourths mile southwest of Lawsonham, just east of the boundary between the quadrangles. From this point the strata rise southeastward, but the exact position of the axis is unknown, as the county to the north has not been surveyed. It seems probable, however, that it passes a short distance north of Lawsonham.

KELLERSBURG ANTICLINE.

This is the principal structural feature of the quadrangles. It corresponds in part with Platt's Bradys Bend anticline and in part with his Kellersburg anticline. Its axis very nearly coincides with that of the Bradys Bend anticline, as mapped by Platt, from the southwest corner of the Kittanning quadrangle to the southeastern part of Sugar Creek Township, but from this locality onward the location of the anticline by the present survey differs greatly from that given by Platt. It is desirable, therefore, to present the evidence upon which the determination here made is based.

The limestone on the axis of the Kellersburg anticline rises very regularly from an elevation of 950 feet in the southwestern part of the Kittanning quadrangle to a point about 1 mile southeast of Fosters Mills, where two wells reveal it at altitudes of 1,310 and 1,330 feet. Midway on the road between Cowansville and Browns Crossroads the Freeport sandstone lies at 1,500 feet above sea, and, since this stratum is about 200 feet above the limestone, the latter lies at 1,300 feet. From this place the strata dip to the north, west, and south, as shown by observations on the limestone and coal beds. One-half mile southeast of Browns Crossroads the altitude of the limestone is 1,240 feet, as shown in a well; at Sherrett its altitude is 1,244, and abundant observations show a constant dip from this point to Phillipston, and a dip of nearly 100 feet to the mouth of Redbank Creek. From the southeast part of Sugar Creek Township to a point about midway between Rimer and Morrows Corner, however, the limestone dips very gradually eastward to below 1,250 feet. This determination is based mainly on the evidence of coal beds. The Upper Freeport coal, whose horizon on the axis of the anticline in Sugar Creek Township must be at least 1,550 feet above the sea, since it is at least 50 feet above the Freeport sandstone, just catches the knobs at 1,500 feet in the vicinity of Peach Hill, thus showing a descent of 50 feet. Allowing an interval of 250 feet between this coal and the limestone, the latter would have an altitude of 1,250 feet near Peach Hill. North of this locality, at a point about 1 mile north of Rimer, the Lower Kittanning coal was struck in a test

well at an elevation of 1,230 feet, showing that the elevation of the limestone at that point is about 1,200 feet. Numerous observations on coal beds and on the limestone direct show that the elevation of the limestone in the northern parts of Washington and Madison townships is 1,200 feet or less. Southward in the vicinity of Morrows Corner the Lower Kittanning coal lies at about 1,170 feet above sea level, and the limestone is at about 1,050 feet one-half mile north of Adrian. The evidence presented above clearly shows that the rocks dip both north and south from a line passing nearly east and west through the above-mentioned point between Rimer and Morrows Corner, and that that line is therefore to be taken as the anticlinal axis which thus connects the Bradys Bend and Kellersburg anticlines.

From the point on the anticline between Rimer and Morrows Corner the axis can be traced without difficulty by means of abundant exposures of the limestone and openings on the Lower Kittanning coal, through Kellersburg, across Redbank Creek between Climax and St. Charles and off the quadrangles northeast of Climax, where the limestone was observed at about 1,360 feet. Numerous observations on the limestone west of Climax, where revealed by old ore strippings and in natural exposures show that it dips regularly from this axis to the southeast until it disappears in the bluff at the southern point of Anthonys Bend, at an altitude of 1,130 feet.

At a point about 2 miles a little north of east of Climax the limestone is quarried at 1,360 feet elevation. Just southeast of New Bethlehem an old ore pit shows its altitude to be 1,110 feet. Between the two points observations indicate regular dip of the limestone. These observations show conclusively that there is neither anticline nor syncline in this region, as mapped by Platt and named the Anthonys Bend anticline and Centerville syncline. The northern extension of the Kellersburg anticline beyond the quadrangles is unknown, but it is a fair presumption that it is continuous with the Anthonys Bend anticline in Clarion County. It is clear, then, that instead of three anticlines with straight axes there is in reality but one anticline with a strongly curving axis, which is very appropriately named the Kellersburg anticline.

BOGGSVILLE SYNCLINE.

Platt mapped the Lawsonham syncline as extending from the head of Cornplanter Run, in a straight line, through Worthington and Cowansville to Lawsonham. Evidence presented in describing the Kellersburg anticline shows that while there is a sag in the anticline north of Morrows Corner the anticlinal structure so predominates in the region that a syncline could not properly be regarded as crossing there. To the northeast there is, however, a transverse buckle in the rocks, which passes in the direction of Lawsonham, and to the southwest there is a distinct syncline, which dies out on the southeastern limb of the Kellersburg anticline near Limestone Run, south of Adrian. This syncline occupies in a general way the position of the south end of the Lawsonham syncline, but Platt located its axis farther west. The Vanport limestone crops out at West Winfield at an altitude of 1,000 feet; near Boggsville it was noted in two wells at altitudes of 680 and 733 feet, showing a dip of 300 feet between the two places. This dip is confirmed by the records of many other wells in this vicinity and also by the fact that the Upper Freeport coal, which has an altitude of 1,240 feet at West Winfield, dips southeastward to an altitude of 920 feet near Boggsville. The strata probably begin to rise southeastward from Boggsville, for wells just off the margin of the quadrangle south of Slate Lick show the limestone at 750 feet above the sea. These facts locate the axis of this syncline pretty definitely near Boggsville, and it is therefore named the Boggsville syncline. This syncline in the southern part of the quadrangle is broad and flat-bottomed, and the position of its axis is rather indefinite. Its location as mapped is based upon an occasional well record and upon careful and thorough stratigraphic tracing in the region. Near Walkchalk the syncline narrows suddenly, and its axis is well determined by the opposing dips of the rocks. Its course north of Walkchalk was determined by observations on the Upper and Lower Freeport coals and by well records and observations on outcrops of the limestone along Limestone Run.

McHADDON ANTICLINE.

This low anticline, whose axis enters the Kittanning quadrangle 2 miles southwest of North Buffalo village, runs in general nearly parallel to the axis of the Boggsville syncline and dies out near the mouth of Limestone Run. Here it merges with the Kellersburg anticline and ceases to be a separate feature. The name is applied because the axis runs near McHaddon.

FAIRMOUNT SYNCLINE.

As mapped by Platt the axis of this syncline follows the river from the southern margin of the Kittanning quadrangle to the mouth of Garrett Run and continues thence in nearly straight line to Redbank Creek near Fairmount. In a general way this location agrees with that of the present survey, but the details differ to some extent. The axis is not straight. From the mouth of Garrett Run it trends about N. 30° E. to Scrubgrass Creek, then swings gradually eastward to a course about N. 60° E., which it follows to about 1 mile east of Mahoning Furnace, where it curves northward and leaves the Rural Valley quadrangle in a nearly north course. The position of this axis is well determined by the opposing dips of traceable coal beds, and at the point where it crosses Scrubgrass Creek it is fixed within narrow limits by the opposite dips of the rocks in the bed of the creek and on the valley walls. From this point to the northern margin of the quadrangle the bottom of the syncline appears to flatten out and the position of the axis is not so well established. Observations on the limestone along Mahoning Creek, and on Redbank Creek, where it is exposed between Fairmount and Oak Ridge, and also on the Upper Freeport coal in a a number of banks and in the Fairmount Company's mines, all serve to indicate that the axis can not be far from the position shown on the map.

A peculiarity of this syncline is the oval depression on the axis on Pine Creek at the mouth of Bullock Run. This is formed by a low cross anticline which crosses the syncline south of Hays Run. The existence of this anticline is proven by stratigraphic tracing, as well as by the fact that two wells on the Starr farm just south of Rayburn Run found the limestone at 870 feet, while along the synclinal axis north of Pine Creek the elevation decreases to 800 feet, and southward it constantly decreases to below 700 feet on the southern margin of the quadrangle.

GREENDALE ANTICLINE.

Southeastward from the axis of the Fairmount syncline the rocks rise to the crest of the Greendale anticline as far north as Mahoning Creek and to the crest of the Brookville anticline north of that creek. The axis of the Greendale anticline enters the Rural Valley quadrangle from the south about 1½ miles southwest of Blanket Hill and follows in general the northeastward course mapped by Platt through Greendale to a point about 1½ miles southwest of Muff. From this point Platt continued it in a straight line to the head of Scrubgrass Creek, where he represented it as dying out. Numerous observations in the Upper Freeport coal, however, show a regular dip both northwestward and southeastward from a line passing from this point through Muff toward Belknap. Along the road from one-half mile southwest of Muff to the high knob at the locality known as Concord Church, the records of nearly a dozen wells show the elevation of the limestone to be nearly 1,400 feet; northwest toward Goheenville wells show a regular dip of the limestone to the altitude of 1,050 feet, and southeast toward Echo a similar dip to 1,000 feet. Following the line indicated above northeastward to Belknap, the Lower Kittanning coal occurs at an elevation of about 1,420 feet, and still northeastward along the same line the coal has been opened near the road intersection at the H. S. Pontius farm and at an intermediate point, at both of which its altitude is 1,420 feet. Still farther northeastward on the road following the top of the bluff of Mahoning Creek, at a point nearly south of the mouth of Glade Run, the limestone has been quarried at an altitude of 1,440 feet. From the line thus traced out the strata dip in both directions, as proved by abundant observations on the outcrop

of the limestone and the Lower Kittanning and Upper Freeport coals, as well as by the elevations of the limestone shown in a number of wells on both sides of the anticline. Platt described the Glade Run anticline as beginning in the vicinity of Echo and running northeastward through Wayne Township to the vicinity of the mouth of Glade Run. No trace of such an anticline was detected near Echo during the present survey, and it is well established by the facts cited above that there is but one anticline in the region which curves in harmony with the Kellersburg anticline; it is appropriately named the Greendale anticline.

BROOKVILLE ANTICLINE.

In the northeast corner of the Rural Valley quadrangle lies the southwest point of the Brookville anticline, in substantially the position mapped by Platt. This anticline plunges rapidly southwestward and disappears as a distinguishable feature near the mouth of Little Mudlick Creek.

The Brookville anticline is separated from the Greendale anticline by a narrow depression running eastward from the Fairmount syncline in the vicinity of Putneyville and passing off the quadrangle at McWilliams. The existence of this depression is well established by observations on the limestone and the Lower Kittanning coal.

APOLLO SYNCLINE.

Platt described the Leechburg syncline as lying next east of the Greendale anticline, extending northeastward and separating it from the Glade Run anticline, and then leaving Armstrong County east of the Brookville anticline. In the survey of the Elders Ridge quadrangle no trace of this syncline could be detected, and it certainly does not extend into the Rural Valley quadrangle. (See Elders Ridge folio.) The Apollo syncline, however, described and mapped by Platt as lying west of the Leechburg syncline and separated therefrom by the Apollo anticline in southern Armstrong County, has been traced into the southern part of the Rural Valley quadrangle.[a] The axis of this syncline enters the quadrangle about 1 mile east of the western boundary of Plum Creek Township and extends northeastward, passing about one-half mile southeast of Blanco and becoming indistinct in the flat-lying strata in the vicinity of Rural Valley. There appears to be a very shallow synclinal depression between Smeltzer and Bryan that is in line with the direction of this syncline and may be regarded as an extension of it.

ROARING RUN ANTICLINE.

Platt mapped this anticline as ending on the north at a point south of the Rural Valley quadrangle and a short distance north of Crooked Creek. It is shown in the Elders Ridge folio, however, that this is a strongly marked and easily traceable feature in the Elders Ridge quadrangle to the south and its continuation as far north as Blanco, in the Rural Valley quadrangle, can be made out from well records. The axis of the anticline enters the quadrangle about 1½ miles west of the axis of the Apollo syncline. The position of the limestone in the Espey well on the axis of the Apollo syncline one-half mile southeast of Blanco is about 860 feet above the sea, and a little more than a mile to the southeast it occurs in the Bell and Wagoner wells at about 1,000 feet above the sea, showing a sharp rise of 150 feet. The rise of the strata, however, can not continue much if any beyond this point, for if it did the Upper Freeport coal would crop out on the hillside to the southeast; it does not, and there is evidence that it lies at considerable depth west of Green Oak, showing that the rocks dip rapidly southeastward from the Roaring Run axis. On evidence furnished by the wells this anticline is believed to curve sharply westward near its point and, like the Apollo syncline, to become lost about 1 mile northeast of Blanco in the nearly horizontal strata along the valley of upper Cowanshannock Creek.

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[a] Second Geol. Survey Pennsylvania, Rept. V, p. 10.

SOUTHEAST CORNER OF THE RURAL VALLEY QUADRANGLE.

As intimated above, the rocks of the southeast corner of the quadrangle lie nearly flat, and owing to the scarcity of well records and to the absence of traceable beds the structural details can not be made out with as much certainty as could be wished. This applies to the region roughly bounded by the 850-foot structure contour along the bases of the Roaring Run and Greendale anticlines. It is believed that the rocks south of Cowanshannock Creek dip regularly toward a depression which extends from Green Oak to the vicinity of Gastown, in the Elders Ridge quadrangle. A number of wells in the vicinity of Atwood show a slight anticlinal structure in that vicinity which may be more pronounced in the territory to the east. The Moore well (485) at Smeltzer, several diamond-drill holes, and the Brush Creek coal bed show a similar anticlinal structure along the North Branch of Cowanshannock Creek. This is possibly the vanishing southwest end of the Port Barnet anticline mapped by Platt. Both of these anticlines are very low and of little importance within this quadrangle.

DIP OF THE ROCKS.

The dips throughout these quadrangles are generally low. The highest are found on the southeast flank of the Kellersburg anticline and probably do not exceed 3° to 4°.

PITCHING AXES.

A notable feature of the anticlines and synclines of the region is the general southwestward pitch of the axes. Within the limits of the quadrangles the axis of the Bradys Bend syncline on the Vanport limestone pitches from 1,150 to 900 feet above sea level, that of the Kellersburg anticline from 1,400 to 950 feet, that of the Fairmount syncline from 1,070 to 650 feet, and that of the Greendale anticline from 1,440 to 1,000 feet. The pitch, however, is not always uniform. The crests of the anticlines in some places run nearly level for long distances, as that of the Greendale anticline in the vicinity of Belknap and Muff, and that of the Kellersburg northeast of Kellersburg and near Craigsville and West Winfield. In other cases they exhibit elevations like the Kellersburg anticline east of Fosters Mills and the Greendale anticline south of Pine Creek. The regular southwestward pitch of the Fairmount axis is interrupted by the cross anticline south of Hays Run already described.

COURSE OF STRUCTURE LINES.

Another notable feature of the structure of the quadrangles is the deviation of the anticlinal and synclinal axes from straight lines. In general each axis is composed of reversed curves. The failure to recognize these facts and the assumption that the folds follow straight northeast-southwest courses led to serious errors in previous attempts to determine and map the structure and to no little confusion to those engaged in drilling for gas and oil.

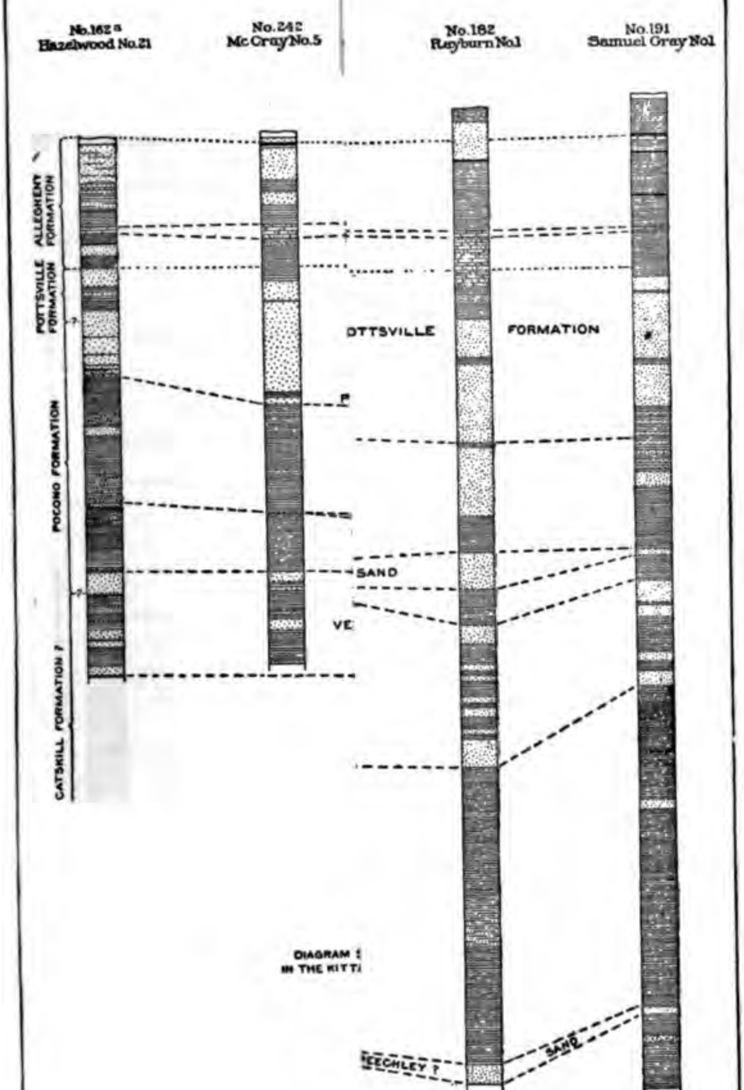
STRATIGRAPHY.

The rocks of which we have knowledge in these quadrangles are treated under two heads, viz, rocks not exposed at the surface and those that outcrop. The former are revealed in deep wells sunk for gas or oil; the latter can be studied directly.

ROCKS NOT EXPOSED.[a]

Sources of knowledge.—Our knowledge of these rocks is derived entirely from the records of deep wells bored for gas or oil and is more or less imperfect. In many cases records have been carelessly kept: strata important from a geologic standpoint, such as bands of red rock or a bed of limestone, have been overlooked or not recorded; and frequently only the oil or gas sands have been noted, thus leaving great blanks in the logs. The methods of measurement introduce some errors. While measurements to the oil and gas sands are mostly made by steel line and are accurate, the depth and thickness of other beds are generally estimated by counting the turns of the cable on the bull-wheel shaft, and errors in computing the length of rope by this method easily occur. In very deep wells the stretching of the cable might

[a] See Pls. I-IV.


No.162 a
Hazelwood No.21
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Mc Cray No.5
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Rayburn No.1
No.191
Samuel Gray No.1
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POTTSVILLE FORMATION
POCONO FORMATION
CATSKILL FORMATION ?
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lead to errors of considerable magnitude. The difficulty of identifying the character of rocks by the relative ease with which the drill penetrates them or by the drillings brought up in the sand pump is also probably a fruitful source of error, especially with observers having no scientific training. To this fact may be and probably often are due in part the lithologic variations recorded for wells in contiguous territory. It may thus happen that important beds that are not recorded are not really absent from the section, but have been overlooked, and this may account for the absence of red beds or beds of limestone from the logs of some wells and their presence in those of others near by. Again, a heavy sandstone in one well might change to a highly arenaceous shale or shaly sandstone in an adjacent well and thus be recorded as slate or shale. At best, observations on rocks in deep-well sections must be confined almost wholly to their lithologic character; only in very rare instances can anything be learned of their fossil contents, a knowledge of which is almost indispensable to the correct determination of the age and stratigraphic position of the rocks.

Thickness.—The greatest depth to which the drill has penetrated below the lowest horizon of exposed rocks in the quadrangles is about 3,100 feet. The deepest wells in this region of which we possess records are the Robert Smith well (No. 9, Pl. I) and a well which was drilled by Mr. Joseph Simpson just off the northern margin of the Kittanning quadrangle, north of Bradys Bend village. The Simpson well (Pl. II), which is over 3,500 feet deep, starts just above the Vanport limestone and, as the lowest horizon of exposed rocks is about 400 feet below the limestone, the well penetrates about 3,100 feet below any rocks exposed in the region. The Smith well is also over 3,500 feet deep but starts at a higher horizon and hence does not reach so low a horizon as the Simpson well. The Kepple well (No. 246, Pl. II) penetrates 2,800 feet below the Vanport limestone and 2,400 feet below the lowest exposed rocks. The Colwell well (No. 543, Pl. IV) at Mahoning Furnace is over 2,700 feet deep and penetrates over 2,800 feet below the Vanport limestone. There are a number of other wells in the quadrangles that penetrate to about the same horizon.

General character.—These unexposed rocks fall naturally into three well-differentiated groups. In general there are, from the top downward, first, 700 to 800 feet of gray shale and sandstone; second, 300 to 700 feet of strata characterized by the presence of varying amounts of red rocks, presumably red shale, and third, prevailingly dark shale with thin sandstone layers, and occasional thicker beds of sandstone to the bottom of the deepest wells. The facts stated above are well illustrated in Pls. I-IV, which show typical well sections of the region.

GRAY SHALE AND SANDSTONE.

This group contains several members of sufficient importance to warrant separate description. With the exception of these members the group is composed mainly of gray sandy shale.

Burgoon ("Mountain") sandstone.—At the top of this group lie about 100 to 175 feet of heavy sandstone, which form the lower part of the "Mountain" or "Big Injun" sand of the driller, the upper 225 feet of which are exposed in the Allegheny Valley on the arch of the Kellersburg anticline. It is proposed to use the geographic name Burgoon sandstone for this stratum, on account of its exposure along Burgoon Creek in the region of the Allegheny Front west of Altoona.[a]

Patton shale.—In many wells a thin band of red shale occurs just below the base of the Burgoon sandstone. This is a widely distributed stratum, and merits attention on account of its importance as a horizon marker. This bed was first described by Richardson (Indiana folio), and named by him the Patton shale on the assumption that it is the same as the red shale that outcrops at Pattons Station on Redbank Creek, in Jefferson County.

Lower sands (gas sands).—In some of the well sections shown on Pls. I to IV a sandstone noted about 150 feet below the Burgoon sandstone is called the "First" sand, but it is by no means certain that the first sand of one well is the same as the first sand of another. This sandstone is sometimes regarded as the equivalent of the Pithole grit of Venango

[a] See Ebensburg folio: Geologic Atlas U. S., folio 133, U. S. Geol. Survey, 1905.

County and the Berea grit of Ohio, but there is no conclusive evidence that that horizon is represented in this region. The bottom of this group of gray shales and sandstones is prevailingly sandy and several beds are distinguished. These are the Murrysville gas sand, about 300 feet below the Burgoon sand; the "Second" or Hundred-foot sand, about 450 feet below the Burgoon sand; and the Thirty-foot sand, just below the Hundred-foot sand. The Hundred-foot and Thirty-foot sands occur at the top of the Venango oil sands of the oil regions.

RED BEDS.

Below the gray rocks occur several hundred feet of strata characterized by greater or less amounts of what the drillers call red rocks, presumably red shale. The proportion of red rocks and the extent of the interval in which they occur vary much in different well records, as can be seen on the well sections. In some records no red rocks are noted; in most, the part of the section through which they are recorded is from about 200 to 350 feet in thickness. In the Kepple well (No. 246) they are noted at intervals through an exceptional distance of 700 feet. These red beds also vary greatly in total thickness and distribution. In some wells they occur as scattered beds of greater or less thickness, separated by beds of dark shale and sandstone; in others they occur as an unbroken mass 300 feet thick; in still others no red beds are noted. It seems hardly credible that they are absent in such wells. It is far more probable that they occur as thin beds which were either not observed or not recorded.

Oil sands.—Associated with the red beds in this region lie the coarse oil-bearing sandstones, known as the Stray, Third, and Fourth oil sands, and the overlying thin sandstones, known as the Blue Monday and Bowlder sands.

DARK SHALES AND THIN SANDSTONES.

The remaining 1,500 to 2,000 feet of strata, making up the third group and extending to the bottom of the deepest well, are mainly composed of gray shales interbedded with thin sandstone layers, to which the drillers apply the name "slate and shells," the sandstone layers being the shells. Occasionally throughout this group thicker strata of sandstone occur, but these are rarely noted as reaching 50 feet in thickness.

Speechley and Tiona sands. In the midst of the third group and from 500 to 700 feet below its top occurs a group of these sands, the upper members of which are known as the Speechley and the lower as the Tiona sands.

GENERAL CORRELATION.

The correlation of the rocks not exposed has been fully discussed in the Kittanning folio, and the discussion need not be repeated here. It will suffice to state that the rocks of group 1 are regarded as Pocono, those of group 2 as Catskill, and those of group 3 as Chemung. This grouping, however, can be regarded as only approximate and tentative.

EXPOSED ROCKS.

CARBONIFEROUS SYSTEM.

General statement.—Most of the rocks described in this region belong to the Carboniferous system. There are, however, certain old gravels of possible Tertiary age and certain deposits belonging to the Quaternary. The Carboniferous rocks are divided into two series, the Mississippian series below and the Pennsylvanian series above. The former series is best developed in the Mississippi Valley. As a general rule it is not coal bearing, but in certain parts of the Appalachian region it includes workable coal beds of limited extent. The Pennsylvanian series includes the coal-bearing rocks or Coal Measures of the Appalachian coal fields, and is typically developed in Pennsylvania. Both series are made up of a number of separate formations, which in turn are composed of various members of local importance. In this area the Mississippian series is represented by the Pocono formation, and the Pennsylvanian by the Pottsville, Allegheny, and Conemaugh formations. A generalized section of these rocks as they occur in the region is shown in Pl. V.

	General character of formation.
ngle. d flags; generally present in some form.	Prevailingly shale of clayey or sandy composition. Thick, coarse sandstone on the hills in southwestern part of area. Mahoning sandstone at the bottom. Thin coal seams and limestone.
e. nning sandstone.	Shaly, with heavy beds of sandstone and beds of limestone with associated iron ores. Several valuable coal seams and beds of fire clay. Source of all the valuable mineral products of the quadrangle, except oil and gas.
gheny River and in vicinity of Craigsville.	Generally heavy sandstone. In many places shaly at top and at horizons of Mercer coal.
	Unconformity
	Mostly a heavy sandstone to depth exposed in quadrangle, with small coals accompanied by shale near top. Runs into an unknown thickness of shale below.

POCONO FORMATION.

General discussion.—Considerable difference of opinion has been expressed regarding the existence of Pocono rocks at the surface along the Allegheny Valley south of Clarion River. In the final report of the First Survey of the State the lowest rocks exposed in the valley were classed by Rogers [a] as belonging to the Pottsville (Seral formation), but in the Second Geological Survey W. G. Platt [b] recognized not only the Pocono sandstone, but also the Mauch Chunk shale as being exposed beneath the Pottsville. This determination was based largely upon the occurrence at McCrea Furnace, on Mahoning Creek, of a bed of siliceous limestone, which Mr. Platt correlated with the well-known bed of a similar character marking the top of the Pocono formation in the Chestnut Ridge region. Lesley, however, in a preface to the same volume, states that it is much more probable that this limestone occurs at the Mercer horizon than at that of the "Siliceous limestone," and that consequently all of the rocks below this horizon exposed along the Allegheny River are parts of the Pottsville

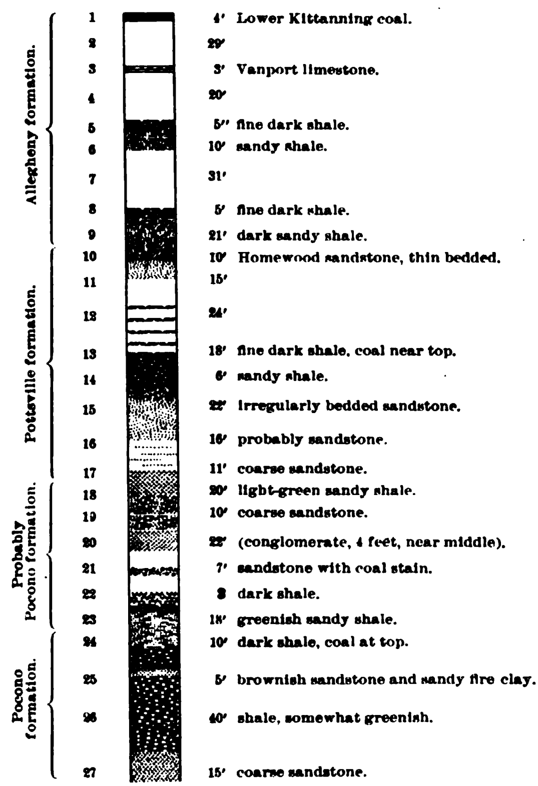

FIG. 3.—Section at Riverview mine, 2 miles below Redbank.

formation, which, he says, consists of three sandy members separated by two shale intervals, as it does in Beaver Valley, the type locality. The accompanying section (fig. 3) shows the character of the rocks under consideration as they are exposed at the Riverview mine, 2 miles south of Redbank.

On purely lithologic grounds it is extremely difficult, if not impossible, to subdivide these rocks into formations and correlate them with divisions recognized in other parts of the field, and the different interpretations that have been put upon them doubtless must be attributed to the absence of well-marked beds.

[a] Rogers, H. D., Geology of Pennsylvania, vol. 2, p. 585.

[b] Rept. H5.

The section shown in fig. 3 is fairly representative of the rocks of this debatable interval and may be considered as typical of this region, except that the Pocono part shows more shale than occurs in some other sections.

The section includes the Lower Kittanning coal and the Vanport limestone, two of the best horizon markers in the region. The top of the Pottsville formation is clearly marked at a distance of 94 feet below the top of the limestone by the Homewood sandstone, which generally is massive in this region, but in this particular section is thin bedded and inconspicuous. This bed is underlain by about 65 feet of shale, which contains several small coal seams and carries a good Mercer flora. The strata underlying the Mercer beds are more difficult to classify, but the first sandstone (Nos. 15, 16, and 17), about 49 feet thick, carries impressions of Pennsylvanian plant stems which show that it belongs to the Pottsville formation, while its position indicates that it is doubtless equivalent to a part or the whole of the Connoquenessing sandstone.

Below the bed just described fossils are few and generally poorly preserved; so far as observed, there are no indications of Pottsville plants below the Connoquenessing sandstone. Good Pocono plants were found from railroad grade up for a distance of 80 feet, but between this horizon and the base of the Connoquenessing sandstone no fossils have been found and it is impossible to say with certainty to which series these rocks belong. The rocks, however, in this intermediate zone resemble the underlying Pocono sandstone more closely than they do the Pottsville, and therefore the base of the Connoquenessing sandstone will be regarded provisionally as the base of the Pottsville formation.

In the eastern part of Pennsylvania, where sedimentation apparently was uninterrupted from Devonian to late Carboniferous time, the Pocono formation consists of a sandy series more than 1,000 feet thick. It is overlain by a great thickness of Mauch Chunk red shale, and this in turn is overlain by the heavy conglomerates of the Pottsville formation. In the Allegheny Valley the Pocono becomes somewhat thinner, the Mauch Chunk is probably absent, and from evidence presented in the discussion of the Pottsville formation it is shown that the interval occupied by the Mauch Chunk in the east is, in this region, represented by an unconformity, and that the general absence of the Mauch Chunk formation, and probably of the upper part of the Pocono also, is due to a period of erosion before the deposition of the Pottsville rocks of the Allegheny Valley.

Character and distribution.—Since the Connoquenessing sandstone rests unconformably upon the Pocono formation, it follows that the beds in actual contact are different in different sections. The unconformity is so slight, the exposures in general so poor, and the beds in contact so often sandstones of nearly identical character that it is impossible to trace the contact between the two formations. As assumed in the section, fig. 3 (p. 27), the plane of division lies about 230 feet below the Vanport limestone. It will be assumed that it holds approximately this position throughout the quadrangles, and the Pocono formation has been mapped and will be described on that basis. The top of the Pocono at the point where Allegheny River crosses the axis of the Kellersburg anticline would accordingly lie at an elevation of about 1,060 feet, making a maximum thickness of 260 feet of Pocono rocks exposed in the quadrangles.

So far as exposed the Pocono formation is composed mainly of a heavy gray to greenish sandstone, the "Mountain" or "Big Injun" sand of the driller, here called the Burgoon sandstone. While the sandstone is prevailingly a heavy and nearly continuous mass, in places it is broken by beds of shale of varying extent and thickness. The section shown in fig. 3 (p. 27) presents the latter phase of the formation, while the section at the mouth of Redbank Creek, where it consists of about 150 feet of coarse, thick-bedded to massive sandstone, passing without a break into the Connoquenessing sandstone above, presents the former and probably more common phase. On the bluff of the Allegheny above Mahoning two or three thin coal seams occur.

The exposures of the Pocono are confined to Allegheny Valley and to the valleys of Redbank and Mahoning creeks. The top of the formation, rising toward the axis of the Kellersburg anticline, emerges from below water between Templeton and Mahoning, reaches

an elevation of 260 feet above the river on the arch of the anticline, and then descends gradually almost to water level near Phillipston, whence it continues, probably just above the river, to the northern margin of the Kittanning quadrangle. The Pocono is above water along almost the whole length of Redbank Creek within the quadrangles. The top of the formation is about 150 feet above water at the mouth of the creek; it descends nearly to water level at Lawsonham; thence it rises to a height of about 100 feet in the vicinity of Leatherwood and to 200 feet on the arch of the Kellersburg anticline between St. Charles and Climax, from which point it descends rapidly and goes under water near the south point of Anthonys Bend. It reappears on the east side of the bend near the tunnel and continues a few feet above the creek to the northern margin of the Rural Valley quadrangle. It is finely displayed at the east end of the tunnel between Lawsonham and Leatherwood, in the bluff south of the latter place, and above the railroad at the east end of the Climax tunnel. On Mahoning Creek it is exposed for a short distance above its mouth and also along the upper part of the creek within the quadrangle from McCrea Furnace, 1 mile south of Eddyville, to the eastern margin. It is brought up here by the Greendale anticline, and its top reaches an elevation of about 160 feet above the creek.

MAUCH CHUNK FORMATION.

In Report H5 of the Second Geological Survey of Pennsylvania, Platt refers certain dark shales exposed in the midst of heavy sandstone in the bluff above Templeton to the Mauch Chunk formation. These shales, however, present no resemblances to the Mauch Chunk shales elsewhere and to all appearances they are lenticular beds of merely local extent, included in the Burgoon sandstone. The only rock in the quadrangles, so far as known, whose character indicates that it belongs to this formation, is a thin bed of red sandstone occurring in the Peter Heilman well No. 2 (313), near the southern margin of the Rural Valley quadrangle. By examining the section of this well shown in Pl. III it will be seen that this bed occurs at the horizon of the Mauch Chunk, and this fact, together with its color, affords grounds for referring it doubtfully to that formation.

Unconformity at base of Pottsville.—As previously noted, the Mauch Chunk formation, which separates the Pocono and Pottsville formations in other parts of the State, is absent from the Allegheny Valley. In southern Indiana and northern Westmoreland counties the Mauch Chunk shows in many well sections, ranging in thickness from a few to more than a hundred feet. It has a thickness of 150 feet in Packsaddle Gap, near Bolivar; of 250 feet in northern and eastern Fayette County, where it includes the Greenbrier limestone; of 180 feet along the Allegheny Front; of 1,100 feet at Broad Top; and of over 2,000 feet at Mauch Chunk. It appears, therefore, that at the close of the Mauch Chunk period an uplift occurred involving western Pennsylvania and extensive areas farther west, which continued until all of the Mauch Chunk had been eroded from northern Armstrong County and surrounding regions. Not only is the Mauch Chunk absent in this section, but the absence of the Loyalhanna ("Siliceous") limestone shows that some of the upper part of the Pocono is also lacking. According to Platt[a] a fragment of this limestone is preserved at McCrea Furnace, on Mahoning Creek above Eddyville, in the eastern part of Armstrong County. Platt's determination was strongly opposed, however, by Lesley,[b] who regarded the limestone in question as more probably representing the Mercer limestone. The writer also has reached the conclusion that the limestone is Mercer, both on stratigraphic grounds and on the evidence of fossil plants collected from the sandstone closely underlying the limestone and determined by David White to be of Pottsville age. Neither is the Loyalhanna limestone known west of the river, though two or three doubtful references to a limestone of similar character occur in some drill records of Butler County.

These facts show that there is an unconformity between the Pocono and Pottsville formations in this region, and this conclusion is further strengthened by the fact that the Pottsville is here but a comparatively thin bed about 140 feet thick, while, like the Mauch

[a] Platt, W. G., Second Geol. Survey Pennsylvania, Rept. H5, p. 144. [b] Op. cit.

Chunk, it thickens to the east, reaching 1,200 feet in the southern anthracite basins of eastern Pennsylvania. It was formerly believed that the thin bed of Pottsville in the western part of the State represented the whole thickness of the formation in the anthracite regions, the difference being due to the difference in the rate of sedimentation: but it is now known to represent only the upper part of the great Pottsville formation of the anthracite regions. There was no uplift and dry-land period in eastern Pennsylvania, but deposition was uninterrupted at the close of Mauch Chunk time and continued until many hundred feet of sediments had accumulated. Toward the close of Pottsville time the eroded surface of the western part of the State became again submerged and was covered by sediments laid down during the latter part of that period. The submergence of the extreme western and northwestern parts of the State must have preceded by a considerable time that of the area under consideration, for in those regions the lowest members of the Pottsville formation are the Sharon coal and its underlying conglomerate, which have no representative in the Allegheny Valley.

A summary of the events outlined above would be as follows: (1) A long period of sedimentation, allowing the accumulation of over 2,000 feet of Mauch Chunk in the eastern part of the State and an unknown, but possibly great thickness in the western part; (2) the elevation and erosion of the areas above described in the western part of the State, and the contemporaneous accumulation of several hundred feet of Pottsville sediments in the anthracite region; (3) the submergence of a portion of the land surface to the west and northwest and the accumulation of the Sharon coal and its underlying conglomerate; (4) the submergence of the remaining dry land and the resumption of sedimentation throughout, toward, but some time before, the end of Pottsville time. It was during this latter period that such Pottsville rocks as occur in the Kittanning quadrangle were deposited.

POTTSVILLE FORMATION.

General description.—The Pottsville formation overlies the Pocono formation unconformably. In the section already given (fig. 3, p. 27) its top lies about 100 feet and its bottom about 220 feet below the Vanport limestone, making the thickness 120 feet, and it has been mapped as having a thickness of from 120 to 140 feet. It is composed in general of three members—the Connoquenessing and Homewood sandstones, separated in the middle of the formation by a stratum of shale 20 feet or more thick, which usually bears one or more thin seams of coal, the Mercer coal and shale. This general character is subject to many variations, however, as will appear in the description of the different members.

Connoquenessing sandstone.—This is the lowest member of the formation. It appears in every section immediately overlying the Pocono, and is a widespread stratum in western Pennsylvania. It is generally a coarse, gray or white, often highly siliceous, thick-bedded sandstone. In some places it is massive and conglomeratic, in others it is shaly or flaggy. It averages about 40 feet in thickness and generally fills most of the interval between the Pocono and the lowest of the Mercer coals.

Mercer shale.—This is a composite member, probably varying from 20 to 40 feet in thickness. It consists mostly of dark shale, which usually carries one or more thin coal seams. In Mercer County a workable seam occurs, and from that region the name was derived. The character of this member as it occurs in these quadrangles is well represented in the section below, which was measured at the Climax clay pits, near the south point of Anthonys Bend:

Section of Mercer shale, etc., at Anthonys Bend.

	Feet.
Sandstone / Sandy shale } Homewood	15
Coal, thin.	
Sandy shale	28
Coal	1½
Fire clay (Mercer or Mount Savage)	10
Connoquenessing sandstone.	

The fire clay rests upon the Connoquenessing sandstone. It is composed of both flint and plastic clay, and is correlated with the Mount Savage clay of Maryland. In the vicinity of McCrea Furnace a bed of sandy limestone occurs about 140 feet below the Vanport limestone and probably represents the Mercer limestone (see p. 27).

Homewood sandstone.—This is generally a heavy gray sandstone, though in places it changes to one of laminated or even shaly character. Its top lies about 100 feet below the Vanport limestone and its usual thickness is about 40 feet.

Distribution of Pottsville.—The top of the Pottsville, rising toward the McHaddon anticline, appears above river level opposite Wickboro, above Kittanning, reaches a height of about 100 feet above the water three-fourths mile below the mouth of Cowanshannock Creek, and then, dipping northeastward, descends below water near the boundary between the quadrangles. The upper layers of the Homewood sandstone have a laminated character where they rise above the river and in the bed of Cowanshannock Creek a short distance from its mouth. At the mouth of Limestone Creek the sandstone is thick and well exposed. The formation rises above the river again below Templeton and continues above to the northern margin of the quadrangles. At Templeton the Homewood is coarse and heavy and yields the blocks at the mouth of the ravine to the east. Along the road between Templeton and Mahoning the Mercer shale and the overlying heavy sandstone, with pockets of coal and stems of *Lepidodendra* at the base, are well exposed. Beyond this point the Pottsville sandstones form conspicuous ledges at various points along the river bluff. The Connoquenessing sandstone, coarse and heavy and overlying the equally coarse and heavy Pocono, is seen in the road leading up the bluff to the flat point between Redbank Creek and the river, and above it the Mercer shale is well exposed in the road. At the mouth of Sugar Creek, opposite East Brady, the Homewood sandstone has changed to shale, below which is the Mercer shale with two thin coal seams, and still lower the coarse and heavy Connoquenessing sandstone, extending down to the creek. A section made in a ravine still farther up the river shows the formation in the same character. In the vicinity of Craigsville the three members of the formation are exposed. The Homewood sandstone, rather flaggy, occurs in a ledge by the creek back of the Buffalo, Rochester and Pittsburg Railroad station; the Connoquenessing sandstone shows at Craigsville and in a railroad cut just above, near creek level, where it is white and thick bedded; the Mercer shale and the blossom of the Mercer coal show between the two sandstones in the road west of Craigsville. The same beds are exhibited on the road from Craigsville to Fosters Mills on both sides of Patterson Creek, but the Homewood sandstone seems to have passed into shale at that locality. On Redbank Creek the Pottsville is above water level from the mouth to New Bethlehem. The heavy white siliceous sandstone at the top of the railroad cut at the west end of the Climax tunnel is Connoquenessing. The Mercer and Homewood members are exposed in the bluff at the south end of Anthonys Bend, where the section given on page 30 was obtained. The heavy sandstone along the railroad track at New Bethlehem, just off the quadrangle, is probably Homewood. At the mouth of Mahoning Creek the bottom of the Pottsville is from 50 to 60 feet above the railroad track. The heavy sandstone ledge along the road up the creek, a short distance above the station, is probably Connoquenessing. The Homewood, rather heavy, shows near water level on Mahoning Creek for one-half mile below the mouth of Scrubgrass Creek. This sandstone is also exposed in the road near the head of the stream east of Kellersburg. The south end of the bridge at Mahoning Furnace rests upon a shaly to laminated sandstone which is probably Homewood. In the lower part of the bluff in the big bend of the Mahoning below Putneyville is a heavy white siliceous sandstone, the top of which is about 110 feet below the Vanport limestone and immediately above which is a coal bed that appears to be the Brookville coal; on these grounds the sandstone is regarded as Homewood. This sandstone shows on the north bluff of the Mahoning just below the intersection of the road from Eddyville with the road along the top of the bluff. The sandstone here is coarse and massive and about 15 feet are exposed. The Connoquenessing shows along the lower part of this road down to the level of Pine Creek. It is also exposed up Pine

Creek for some distance. In the road cut in the bluff east of the Mahoning at Eddyville, the Connoquenessing is well shown as a coarse, gray, heavy-bedded sandstone; at its top is a bed of shale several feet thick, containing a layer of black shale that probably represents one of the Mercer coals. The various members of the Pottsville are fairly well exhibited in the bluffs of Mahoning Creek and along the roads in the vicinity of McCrea Furnace, 1 mile above Eddyville. The sandstones are also well displayed in the gorge of Glade Run farther east.

ALLEGHENY FORMATION.

General description.—This is composed mainly of a succession of shales and sandstones about 350 feet thick and extending from the Pottsville formation below to the top of the Upper Freeport coal above. The workable coal seams from which it derived its former name, the Lower Productive Coal Measures, form its distinguishing feature. Besides coal it contains valuable beds of limestone and fire clay. A general outline of its various members will be given here, leaving to a subsequent chapter the more detailed description of those of economic importance. Several sandstone members are described below, which are locally developed as lenses of greater or less extent along the same horizon between the various coal seams. In addition to the sandstones noted, others of small extent may occur in any position. Where the intervals between the coals are not more or less completely occupied by these sandstones, they are filled with shale.

Distribution.—The Allegheny formation is exposed along nearly every valley in the quadrangles, and makes the surface over large areas along the Kellersburg anticline from Winfield to the northern margin of the region and along the Greendale and Brookville anticlines from Pine Creek to the northeast corner of the Rural Valley quadrangle. In the northwest corner of the Kittanning quadrangle the Allegheny formation is mostly concealed by the overlying Conemaugh rocks. It is also rather deeply buried throughout the Boggsville syncline, in the southeast corner of the Rural Valley quadrangle, in Plum Creek and Cowanshannock townships, and in the southeast corner of Wayne Township. Large tracts are well under the cover of the overlying rock in the interstream areas of the Fairmount syncline.

Brookville coal.—This is a generally worthless coal lying from 10 to 20 feet above the top of the Pottsville and separated therefrom by shale and fire clay. Its blossom shows at many points throughout the quadrangles, but it is thin except along the upper part of Mahoning Creek, within the Rural Valley quadrangle, where it reaches at points a thickness of 4 feet.

Craigsville coal.—On Buffalo Creek, 2 miles northwest of Craigsville, a coal 3 feet thick, 50 feet below the Vanport limestone, and 15 feet below the Clarion coal, which is also exposed, has recently been opened and worked. What appears to be the same coal has been opened on the hill one-half mile north by west of Craigsville, and is reported 3½ feet thick. The blossom of a coal 50 feet below the limestone shows about 1 mile north of Craigsville, along the road to Fosters Mills, and in the same locality the Brookville coal has been opened about 50 feet lower. At West Winfield streaks and pockets of coal occur in a heavy sandstone 40 feet below the limestone and 25 feet below the Clarion coal, and this probably lies at the same horizon as the coal in the vicinity of Craigsville. A small coal was observed in this position in the bluff of the Allegheny just above Templeton. It seems quite certain, therefore, that there is a coal at these places between the Brookville and Clarion coals. So far as the writer is aware, the three coals in this relation have n' ' been observed elsewhere in these quadrangles. It does not seem possible to identify this with any previously described coal, so the name Craigsville is here used for it, on account of its good development at that place.

Clarion sandstone.—At the old mill on Cowanshannock Creek, 1 mile above its mouth, the following section (fig. 4) is exposed:

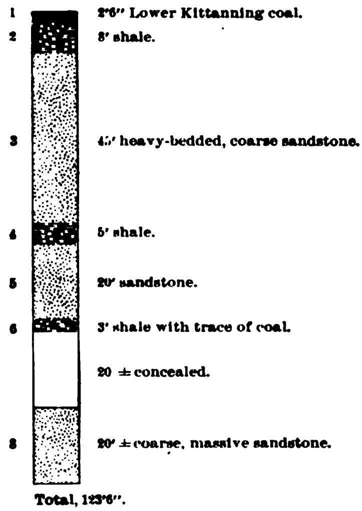

FIG. 4.—Section at old mill on Cowanshannock Creek, a mile above its mouth.

In this section the thickness of the concealed interval and of the sandstone (8) were estimated and may be considerably in error. The sandstone (8) shows in the bed of the creek and in a ledge washed by the water, whence have come the great bowlders of coarse white sandstone that fill the channel at the old mill. Near the mouth of the creek the Vanport limestone is about 50 feet below the Lower Kittanning coal. No trace of the limestone was detected in the above section, but its place is apparently occupied by the shale marked 4. The shale with traces of coal (6) probably represents the Clarion coal, and the sandstone (8) at the bottom of the section, which may occupy most of the concealed interval also, is probably the Clarion sandstone described in the Pennsylvania report on Armstrong County. Its bottom would lie at least 60 feet below the Vanport limestone and its thickness may reach 40 feet. An interesting feature of this section is the fact that the entire interval of over 100 feet below the Lower Kittanning coal is nearly filled with coarse, thick-bedded sandstone. A comparison of this section with others in the vicinity affords a good illustration of the variable nature of Coal Measures stratigraphy. At West Winfield a heavy sandstone extends from close below the Clarion coal to water level. Its bottom is not exposed, but it is at least 50 feet thick. At both the above localities the sandstone was identified as Pottsville by the geologists of the Second Survey,[a] who appear to have based their identification on its coarse, massive character. On account, however, of its relations to the Clarion coal and Vanport limestone, the writer prefers to regard it as Clarion.

The ledge of coarse, thick-bedded sandstone along the road just west of the south end of the bridge at Mahoning Furnace and that on the opposite bank 1½ miles below the bridge are probably Clarion, as is also the coarse white sandstone in the road one-half mile south of New Bethlehem. The great masses of coarse, massive sandstone in the ravine of Camp Run south of McCrea Furnace also came from this stratum, which outcrops near the top of the hill not far from the eastward turn of the road along the top of the bluff of the Mahoning. The size of the blocks shows that the sandstone is at least 20 feet thick. Here again Platt[b] identified it as Pottsville. Farther east, in the road near the schoolhouse at the head of Glade Run, is another exposure of this sandstone.

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 101; Rept. Q, p. 93. [b] Op. cit., Rep't. H5.

Clarion clay.—This is a bed of plastic clay underlying the Clarion coal. It is present as a bed 6 to 8 feet thick at Kittanning, West Winfield, and in the vicinity of Templeton and Mahoning.

Clarion coal.—The position of this coal is 15 to 25 feet below the Vanport limestone and 50 to 70 feet above the Brookville coal. So far as known it probably rarely exceeds a foot in thickness throughout the quadrangles. At West Winfield, however, it is over 3 feet thick.

Vanport limestone.—This is universally known throughout western Pennsylvania as the Ferriferous limestone, because it bears on its upper surface the buhrstone ore that was once extensively used in the manufacture of iron. It has been an important guide in drilling operations, for when its position is known the driller can estimate the depth to the gas and oil sands.

The Vanport is a bluish-gray limestone of a good degree of purity, running generally over 90 per cent carbonate of lime. Its numerous fossils show that it is of marine origin. It runs quite uniformly 8 feet thick over most of these quadrangles, but at West Winfield, on Rough Run, it reaches a thickness of 22 feet. Many well records in the southwest part of the Kittanning quadrangle show as great a thickness. It is well exposed on Buffalo Creek for a mile above the junction of Rough Run, and it outcrops along the run for half a mile above West Winfield, where it has been laid bare in quarrying operations. The horizon of the limestone is exposed on Buffalo Creek and its tributaries along the arch of the Kellersburg anticline from 2 miles below Buffalo Mills to Nichola, and on Patterson Creek to the vicinity of Fosters Mills. The limestone rises above the river at Kittanning and is present to the mouths of Limestone Run and Cowanshannock Creek, from which locality to a point about 2 miles south of Templeton it can not be found on either side of the river and is probably wanting. At the last-mentioned point it reappears on both sides of the river and persists to the vicinity of Hooks, rising to a height of 400 feet above water on the axis of the Kellersburg anticline. From Hooks to north of Rimer it is absent on both sides of the river, and on the west side it is not known for a still greater distance. Along the remaining part of the Allegheny, on its small western tributaries entering above the mouth of Redbank Creek, and along the entire length of Redbank and Mahoning creeks within the quadrangles it is almost everywhere present as a bed about 8 feet thick. On Scrubgrass Creek above Goheenville and on North Fork of Pine Creek it is exposed for a distance of about 3 miles on the western limb of the Greendale anticline. On South Fork of Pine Creek its horizon is exposed across the arch of the Greendale anticline and it is probably present from Pine Furnace to one-half mile below Echo. On Cowanshannock Creek its horizon is raised above the stream by the anticline nearly the whole distance across Valley Township, where it can be traced about 8 feet thick from its western outcrop to a point about 1 mile west of Greendale; east of that point to Cowanshannock Township, where its horizon goes below the creek, nothing could be found or learned of it, and it appears to be absent.

Kittanning sandstone.—This occurs locally between the Vanport limestone and the Lower Kittanning coal. It is very heavy and coarse on Rough Run above West Winfield, where it is exposed in a quarry. The thickness laid bare is 40 feet, and apparently it is not fully exposed. The upper 45 feet of sandstone in the section at the old mill on the Cowanshannock is Kittanning.

At the point where the Greendale anticline crosses Cowanshannock Creek a heavy sandstone occurs below the Lower Kittanning coal that apparently cuts out the Vanport limestone. This sandstone yields large bowlders, and Platt [a] evidently was misled by their character, for he regards the sandstone as Pottsville, whereas in reality the Pottsville scarcely rises above water at this point, as is shown by the fact that the Upper Freeport coal is but 340 feet above the level of the creek. Furthermore, a fire clay that is probably Clarion shows in the road by the schoolhouse just west of Greendale, and near creek level

[a] Second Geol. Survey Pennsylvania, Rept. H5.

below the schoolhouse a thin coal occurs which corresponds exactly in position with the Brookville and probably is that bed.

This sandstone is especially prominent as a ledge 20 feet thick along the west side of the Allegheny from opposite Ewing to above Mosgrove. It occurs as a coarse, thick stratum immediately overlying the Vanport limestone at Pine Furnace and at the mouth of Beaver Run. It is very coarse and thick bedded at the top of the west bluff of the Allegheny opposite Rimer, where it is well displayed in the head of a ravine and in the road leading down to the river. It also closely overlies the limestone in the vicinity of Rock Run north of Redbank Creek.

Kittanning fire clay.—This is a bed of plastic clay of varying thickness occurring below the Lower Kittanning coal and probably present throughout the quadrangles.

Lower Kittanning coal.—This coal seam lies from 15 to 50 feet above the Vanport limestone, the more usual interval being from 30 to 40 feet. In the Kittanning quadrangle this coal appears to be present and from 3 to 4 feet thick wherever its horizon is exposed, and it probably underlies the entire quadrangle except in the limited areas from which it has been eroded by the streams. In the Rural Valley quadrangle it occurs with a thickness of 3 to 4 feet throughout most of Madison, Washington, and Rayburn townships, and also along Mahoning Creek and its tributaries east and south of Eddyville. In the intermediate territory occupied by the Fairmount syncline the coal appears to be thin. It is deeply buried in the southern part of the Rural Valley quadrangle and also in the area occupied by the Boggsville syncline in the Kittanning quadrangle and nothing definite is known of it in those areas, though in an occasional well record a coal 3 to 5 feet thick is reported at its horizon. Too much reliance should not be placed upon such report, however.

This coal is usually associated with shale and fire clay, but on Hays Run, at the mouth of Pine Creek, along the east side of the river for a mile or more above Mosgrove, and at Adrian it has a roof of coarse, heavy sandstone 20 feet thick. On Scrubgrass Creek below Goheenville it is immediately overlain by black shale, above which is a heavy sandstone.

Middle Kittanning coal.—This coal lies from 30 to 50 feet above the Lower Kittanning coal, and the two are usually separated by shale, though, as noted in the preceding paragraph, a heavy sandstone occurs between them in places. This coal appears to be persistent throughout the quadrangles as a bed which is generally thin but may locally reach a thickness of 2 to 3 feet.

Upper Kittanning coal.—From 40 to 60 feet above the Middle Kittanning lies the Upper Kittanning coal. The interval is occupied by shale. This seam is usually a mere streak, but in many places swells suddenly to a local deposit of cannel and bituminous coal several feet thick. A good example of this occurs at Somerville, where the coal is mined. At the opening of the mine the seam consists of bituminous coal 2 feet thick; this soon increases to 5 feet, then the floor drops rapidly and cannel comes in beneath the bituminous coal until the seam becomes 12 feet thick. This thickness must be of small extent, for no trace of the seam is visible in the almost perpendicular bank of Holder Run, one-half mile below the mine, where it should outcrop. Cannel coal usually occurs in such deposits, and from this characteristic of the Upper Kittanning seam has originated the name "pot vein," commonly applied to it.

Freeport sandstone.—This occurs between the Upper Kittanning and Lower Freeport coals and often immediately overlies the former. It is a more persistent stratum than any of the other sandstone members of the Allegheny formation. In character it varies from laminated or flaggy and fine grained, as at Weskit, to coarse, massive, and conglomeratic, as in the vicinity of Worthington, where it is at least 50 feet thick. It is well developed along Buffalo Creek. At Boggsville it is the heavy sandstone at creek level at the east end of the village. Below the mouth of Marrowbone Run it rises as a ledge 20 feet or more above the water of Buffalo Creek. In the vicinity of Buffalo Mills, Worthington, and Craigsville its presence is made known by the large masses of a conglomeratic sandstone that strew the surface. At the head of the ravine running from Worthington to Buffalo Mills it is exposed 50 feet thick. In the hills northwest of Craigsville it is heavy and yields masses 15 to 20 feet high. Near

Fosters Mills it crops out in conspicuous ledges. It lies at the surface over the high, flat ridge in the southeastern part of Sugar Creek Township, and has been the controlling factor in the formation and preservation of that surface. The large bowlders of coarse sandstone and conglomerate at Somerville come from the Freeport sandstone, which also furnishes the bowlders along Buffalo Run 1 mile east of Rattigan. It is well developed on the high knobs in Madison Township south of Redbank Creek. It is particularly heavy and conspicuous, apparently 40 to 60 feet thick, at the head of a ravine south of Mahoning Creek, about 1 mile east of the northwest corner of Wayne Township. On the north side of Mahoning Creek, opposite the mouth of this ravine, great masses of sandstone occur near the top of the bluff which probably come from this stratum. The Freeport sandstone shows in good thickness in a ravine east of Templeton. It is coarse and heavy at the mouth of Bullock Run, where it rests upon the Upper Kittanning coal, and at Pine Furnace, where it is in contact with that coal or closely overlies it. The large blocks of coarse conglomeratic sandstone on the hillside above the old mill on Cowanshannock Creek near the margin of the Kittanning quadrangle come from the Freeport sandstone, which also outcrops on the west side of the hill high above the river. This sandstone shows along the bluff between Kittanning and Garrett Run. It is extensively exposed and quarried on Garrett Run about 1 mile above its mouth, where it is about 40 feet thick, and along the railroad between the southern margin of the quadrangles and Kellys station.

Lower Freeport limestone.—This bed is generally inconspicuous or absent throughout the quadrangles. It is described by I. C. White[a] as an impure ferruginous bed 5 feet thick on Rough Run. In the cut along the highway just north of Garrett Run it shows about 2 feet thick, and is apparently of the same character as on Rough Run.

Lower Freeport iron ore.—According to White[b] this occurs as a bed of limonite and carbonate mixed, lying just above the lower Freeport limestone and 4 feet below the Lower Freeport coal. It is developed so far as known only on Rough Run and in the western part of West Franklin Township.

The stratigraphic relationships of these beds are shown in the following section taken from White:[b]

Section of Lower Freeport iron ore.

	Feet.
1. Coal, Upper Freeport (reported)	3
2. Concealed	50
3. Massive sandstone (Butler sandstone)	15
4. Coal, Lower Freeport	0 to 2
5. Fire clay	4
6. Iron ore (Lower Freeport)	1½ to 6
7. Limestone (Lower Freeport)	5

Lower Freeport coal.—This coal lies from 40 to 50 feet above the Upper Kittanning. Where the Freeport sandstone is absent the interval is occupied by shale. The coal is variable in thickness and over the larger part of the quadrangles is probably less than 2 feet thick.

Butler sandstone.—A coarse, heavy sandstone occurs locally between the Lower and Upper Freeport coals. This is the Butler sandstone of I. C. White.[c] It occurs in the railroad cut on Buffalo Creek about 1 mile north of Boggsville. It overlies the Lower Freeport coal on both branches of Buffalo Creek in southern Donegal Township and at Walkchalk, where it appears to fill nearly the whole interval, which probably does not exceed 30 feet, between that coal and the Upper Freeport. In the vicinity of Bradys Bend it occurs as a thin-bedded sandstone 30 feet thick, as shown in the section below. In the river bluff south of the large island midway between Templeton and Mosgrove this sandstone is 10 feet thick, with the two coals above and below it exposed. At the road crossing near the head of Hays Run this stratum is exposed as a ledge of coarse, heavy sandstone 10 feet thick. It reaches its best development, however, in the vicinity of Deanville, where it is a coarse, gray conglomeratic sandstone at least 20 feet thick, underlying the Upper Freeport coal. It outcrops

[a] Second Geol. Survey Pennsylvania, Rept. Q, p. 94. [b] Loc. cit. [c] Op. cit. p. 47.

as a ledge 20 feet high on the brow of the bluff of the Mahoning south of Deanville and forms the spur at that place. On the hill northwest of Deanville it is particularly heavy. It occurs close beneath the Upper Freeport coal along the Indiana pike, where it crosses the head of the first run northwest of Blanket Hill, and is there coarse and heavy. At the head of Garrett Run it occurs in the same position but has a laminated character.

The interval between the Upper and Lower Freeport coals, however, is usually occupied mainly by shale. The Freeport fire clay immediately underlies the Upper Freeport coal. Below the fire clay the Freeport limestone occurs over considerable tracts, and below the limestone a bed of iron ore is known to exist over small areas. The following section (fig. 5), taken from Report H5 of the Second Geological Survey of Pennsylvania, will show the relations of these beds:

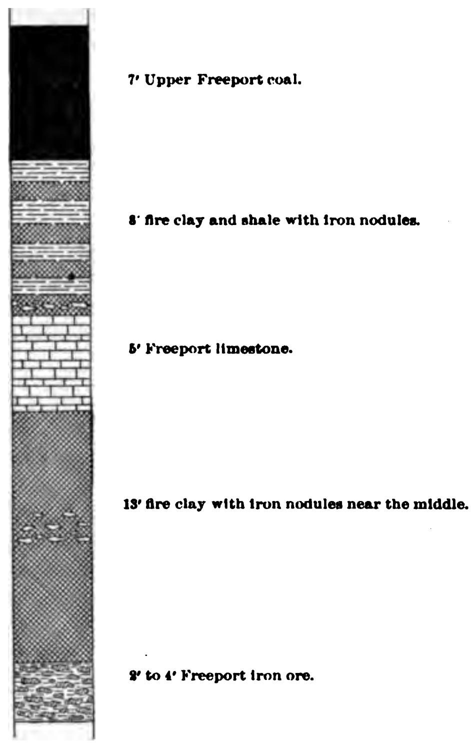

FIG. 5.—Section of Upper Freeport coal and associated clay and iron ore at Bradys Bend.

Upper Freeport fire clay.—The fire clay is usually plastic and from 3 to 5 feet thick, but south of Chicora a considerable area of flint clay occurs at this horizon. The clay is almost universally present immediately underneath the coal. At Bradys Bend a thick bed of clay occurs beneath as well as above the limestone, as shown in the section. This is probably an unusual occurrence.

Upper Freeport iron ore.—This is a purely local deposit, occurring 20 feet below the Upper Freeport coal and below the Freeport limestone. It is known only in the vicinity of Bradys Bend. At Bradys Bend it is described as a solid, compact, very argillaceous layer running about 2 feet thick, but occasionally reaching 4 feet, and having a layer of iron nodules below.

Upper Freeport limestone.—This stratum occurs from 6 to 10 feet below the Upper Freeport coal. It is not persistent, but occurs in detached areas throughout the quadrangles. It ranges up to 28 feet in thickness, but this maximum is attained only in the vicinity of

Manorville and Ford City and holds over but a small area. This limestone is generally nonfossiliferous. A few minute gasteropods have been reported from various places. It appears to be entirely destitute of marine fossils, and is probably of fresh-water origin. The extreme paucity of organic remains may indicate that it is not of organic origin. Possibly it was precipitated from fresh water charged with carbonate of lime in solution.

Upper Freeport coal.—From 20 to 60 feet above the Lower Freeport coal occurs the Upper Freeport coal, which is the top member of the Allegheny formation. Throughout the Kittanning quadrangle the interval between the two coals appears to vary from 30 to 40 feet, but in the Rural Valley quadrangle the variation is greater. On Hays Run, in the river bluff midway between Mosgrove and Templeton, and in the hill south of Dee, an interval of 20 feet was observed. Farther east, in the region from West Valley to Blanket Hill, an interval of 60 feet prevails. From New Bethlehem eastward, except in localities where the Butler sandstone is well developed, the interval is mainly 40 feet. The Upper Freeport coal is generally persistent where not eroded, and is from 3 to 4 feet thick. In some places it is thin, shaly, and worthless. This character is reported in the vicinity of Frenchs Corner and in eastern Donegal Township. On Sipes Run it could not be found, and is probably wanting. In the vicinity of Boggsville it is thin, and on Cornplanter Run it is variable, being cut out in places by the overlying Mahoning sandstone. In the river bluff west of Ford City it is only a thin layer where exposed. These areas of poor development are probably only local exceptions to the generally valuable character of the seam. It has been eroded from large tracts in both quadrangles along the axes of the anticlines, especially in the northern part, but it is present throughout the deeper part of the Fairmount syncline, except along the valleys of the larger streams crossing the syncline. In the Boggsville syncline and in the Rural Valley quadrangle southeast of the Greendale anticline the seam is present, but under deep cover.

Gallitzin coal.—This is an appropriate place to discuss the Gallitzin coal. Platt identified the coal at the Yatesboro No. 2 mine, which is said to be on the Patterson farm, as the Gallitzin, which he claimed occurs 50 feet above the Upper Freeport coal and has a considerable extent in the upper Cowanshannock Valley. The coal at the Yatesboro No. 2 mine, however, lies about 240 feet above the Vanport limestone, as shown by several gas wells in the locality. This is the usual distance between the limestone and the Upper Freeport coal in the Cowanshannock region, a fact that points strongly to the conclusion that the coal in question is Upper Freeport. Furthermore, Yatesboro No. 2 mine is at nearly the same elevation as Yatesboro No. 1, on the south side of the creek, and in strike with it. Yatesboro No. 1 mine is conceded to be in the Upper Freeport, and it is highly probable that the seam at Yatesboro No. 2 is the same. On these grounds Platt's identification is believed to be erroneous. No coal was observed in the region 50 feet above the Upper Freeport, but a thin seam occurs about 100 feet above, which is described farther on as the Brush Creek coal and which, in position relative to the Upper Freeport coal, corresponds with the Gallitzin coal of Cambria County.

CONEMAUGH FORMATION.

General character and distribution.—The Conemaugh formation extends from the Upper Freeport coal below to the bottom of the Pittsburg coal above. It was formerly known as the Lower Barren Measures on account of the fact that it is generally destitute of workable coals. In some parts of Pennsylvania, however, such coals of limited extent occur, sometimes associated with thin limestones. The great mass of the formation is composed of a succession of shale and sandstone strata, the shale being commonly, perhaps prevailingly, sandy. The sandstone is variable in thickness and occurrence. In some regions several strata may be developed, in others a smaller number, and in others there may be scarcely any sandstone from the bottom to the top of the formation. In such cases the formation is composed almost wholly of shale without any distinctive beds. The total thickness varies from 600 to 700 feet.

Within these quadrangles the Conemaugh formation is mostly composed of shale, with thin sandstone layers interbedded. In many places a heavy sandstone occurs near the base of the formation, and in the southwest corner of the Kittanning quadrangle a heavy sandstone occurs at a higher horizon and forms the surface of the elevated level areas there. The upper part of the formation has been eroded from the quadrangles. The greatest thickness of Conemaugh rocks remaining exists in the high hill contoured at 1,540 feet above the sea in the northwestern part of Plum Creek Township. About 400 feet remain in the high hill contoured at 1,600 feet in the southeast corner of Wayne Township and in the knob three-fourths of a mile north of Sistersville, in the Kittanning quadrangle. Nearly all of the Conemaugh formation has been removed from the Kellersburg arch from west of Buffalo Mills to the northern margin of the quadrangles, and only small patches remain on the Greendale anticline between Pine Creek and the high knob 1 mile northwest of Muff, beyond which point the formation is absent. Considerable areas of Conemaugh rocks exist in the northwest corner of the area along the axis of the Bradys Bend syncline and the Fairmount syncline. They form the surface over a considerable strip along the southern margin, and cover most of Cowanshannock Township and the southeast corner of Wayne Township.

Mahoning sandstone.—Much confusion exists as to what beds should be included in this sandstone. So far as the writer can discover, it was first described by Lesley[a] as composed of two beds of sandstone 35 feet thick, separated by 25 feet of shale. I. C. White[b] describes it in almost identical terms, but makes the sandstone members 40 to 50 feet in thickness, with a bed of shale between, the whole varying in thickness from 100 to 150 feet. In an earlier work[c] the same writer restricts the name to the lowest member of the triple group. For reasons that have been fully stated in the Kittanning folio, the writer has decided to apply the name only to sandstones lying between the Upper Freeport and Brush Creek coals, an interval of 70 to 100 feet, as described on page 40.

The Mahoning sandstone usually lies at the base of the Conemaugh formation and closely overlies the Upper Freeport coal. It may, however, occupy a higher position and be separated from the coal by a shale bed of variable thickness. It is generally well developed in the southern part of the Kittanning quadrangle, and occurs at various points in the Rural Valley quadrangle. It varies from a medium-grained, flaggy, or even shaly to a coarse and thick-bedded sandstone, and runs from 10 to 40 feet thick. On the hills immediately southeast of Kittanning it is flaggy to shaly and 30 feet thick, and at Ford City and eastward it is flaggy and rather coarse. At the quarry west of the river nearly opposite Ford City it is 40 feet thick, coarse, thick bedded, and sometimes conglomeratic. It exhibits this thick-bedded character at numerous exposures in the southeastern part of North Buffalo Township and along Glade Run nearly to Walkchalk, where it yields bowlders of coarse white sandstone that probably mingle on the slopes with those of similar character from the Butler sandstone, which is also heavy at this locality. North and east of Walkchalk it becomes more flaggy and to the west seems to disappear entirely. Along the little run entering Glade Run from the north at North Buffalo post-office it is coarse and heavy. It shows again near the mouth of Marrowbone Run and along Buffalo Creek a short distance to the north as a rather coarse, flaggy rock. It exhibits the same character on Sipes Run about a mile above its mouth and becomes coarser and heavier on Cornplanter Run west of Boggsville, where it immediately overlies the Upper Freeport coal and often cuts out that seam. On the east fork of Buffalo Creek about 2 miles north of Rattigan it is coarse and conglomeratic. Along the western margin of the Kittanning quadrangle, from west of Fenelton northward to Karns, the Upper Freeport coal seems to be immediately overlain by about 20 feet of shale, above which there is a greater or less thickness, though scarcely exceeding 20 feet, of sandstone, generally thin bedded and flaggy, but sometimes coarse; this probably represents the Mahoning. In the northeast quarter of the Kittan-

[a] Manual of Coal and its Topography, 1856, p. 97.
[b] *Bull. U. S. Geol. Survey* No. 65, 1891, p. 95.
[c] *Second Geol. Survey Pennsylvania*, Rept. Q, p. 36.

ning quadrangle it seems to be only locally present. In the bluff south of the river midway between Mosgrove and Templeton, the sandstone is 50 feet thick and rests upon the Upper Freeport coal. In the western part of Mahoning Township its presence is indicated by the large bowlders of coarse sandstone that strew the surface in many places. It is here 40 to 50 feet above the Upper Freeport coal. The considerable areas of nearly flat land in this region are probably due to the presence of this sandstone. On the road from Oakland to Putneyville, near the top of the hill 1 mile northwest of Putneyville, the Mahoning is well exposed in the road cut as a coarse, very thick-bedded sandstone 40 to 50 feet thick, and is separated from the Upper Freeport coal by about 20 feet of shale. On the ridge north of McNees, between Cowanshannock Creek and Mill Run, the Mahoning takes the form of conglomerate, large blocks of which occur near the crest of the ridge and run down the north side nearly to the creek. About 1 mile northwest of Blanket Hill, north of Mill Run and about 100 feet above it, the sandstone crops out in a bold ledge 20 feet thick. Near the head of the first run northwest of Blanket Hill it is heavy and immediately overlies the Upper Freeport coal at a bank on the east side and yields large blocks from a position apparently considerably higher on the west side. At the head of Garrett Run it is flaggy and closely overlies the Upper Freeport coal

Mahoning coal (?).—At the intersection of the roads one-half mile east of Beatty's mill, which is on Buffalo Creek about one-half mile north of the mouth of Marrowbone Run, there is a good coal bloom about 40 feet above the Upper Freeport coal and just above the Mahoning sandstone. This coal was noted in several places northward for 1½ miles along the road toward Worthington. It is accompanied in a number of places by a thin limestone. South of the road crossing above mentioned the coal was not seen, but its limestone was traced for a mile along the road to Slate Lick. This coal was not observed elsewhere in the Kittanning quadrangle, but in the Rural Valley quadrangle, on the Indiana pike near the head of Rupp Run, a coal is exposed 1 foot thick, 25 to 30 feet above the Upper Freeport, and the blossom of a coal apparently at the same horizon occurs in the road a short distance west of Bryan. These coals may probably be correlated with the coal at Beatty's mill. They occur at the horizon of the Mahoning coal of Maryland.[a]

Brush Creek coal.—Throughout the southern half of the quadrangles there is a persistent bed of black shale or coal, or both coal and shale, running from 70 to about 100 feet above the Upper Freeport coal. This coal occurs at the same horizon and is undoubtedly the same as the Brush Creek coal, described by I. C. White,[b] in southern Butler County. In the Kittanning quadrangle the black shale is often very conspicuous and generally contains the coal, but in the Rural Valley quadrangle the shale does not occur, though the coal appears to be rather thicker and more persistent. The shale is generally about 5 feet thick, but in a few places thickens to 20 feet. The latter thickness is well shown at the crossroads near the church about 1¼ miles southeast of Worthington. The coal varies from a few inches to 2½ feet in thickness. On account of its importance as a horizon marker, the distribution of this bed warrants a pretty thorough description. It may be seen along the road between Weskit and Walkchalk, in the road on the hilltop west of Weskit, on the ridge road north of North Buffalo post-office, one-half mile east of Beatty's mill, on the road between the mill and Weskit, along the road from Beatty's mill to Worthington, beyond Worthington on the road toward the head of Long Run, along the road westward over the hill between the head of Sipes Run and Buffalo Creek, in the road westward over the hill from Sipes Run, and in a ravine near the road one-fourth mile northeast of Boggsville. It was observed on the Indiana pike on the hillside above the head of Rupp Run, where it is 90 feet above the Upper Freeport coal, and along the ridge road in Rayburn and Valley townships from one-half mile west of the boundary line in Rayburn Township to about 1 mile east of West Valley. At one point on this road it has been opened and is reported 2½ feet thick. It appears to be here 100 feet above the Upper Freeport coal. The blossom of this coal shows at several points along the road from Yatesboro to Smeltzer

[a] Maryland Geol. Survey, vol. 5, p. 303.
[b] Second Geol. Survey Pennsylvania, Report Q.

and about one-fourth mile east of Rural Valley the coal was seen in the road and is about 15 inches thick. It has been opened near the forking of Cowanshannock Creek at the road corners where the road starts south to Atwood along the western margin of the quadrangle, and is reported 20 inches thick. The Upper Freeport coal is reported to have been reached in a diamond-drill hole near this opening at a depth of 100 feet, showing that the interval between the two coals here is about 100 feet, and that accords well with drill records at Rural Valley.

Cambridge limestone (?).—At a few points a thin, dark limestone, carrying an abundance of marine fossils, occurs. Its horizon is not definitely known, but it appears to be above the Brush Creek coal. It is exposed and is 6 inches thick in the midst of shale on the Indiana pike just west of where it crosses the head of the first run in the Rural Valley quadrangle, one-half mile east of its western boundary. It also occurs by the roadside on the easternmost road running north and south in the southeast corner of Wayne Township, at a point about 1½ miles north of the southern boundary of the township and one-half mile west of the margin of the quadrangle. A thin, impure limestone with fossils was also observed on the road from the ridge down to Glade Run due west of Ford City, in the Kittanning quadrangle. This limestone is of interest as showing that marine conditions prevailed at least locally for a brief period in the region. It is possibly to be correlated with the Lower Cambridge limestone of Ohio and Maryland.[a]

Bakerstown coal.—About 75 feet above the Brush Creek coal and 150 feet above the Upper Freeport coal another small and probably worthless coal occurs in the southwestern part of the Kittanning quadrangle. Its blossom was observed at a few points in west North Buffalo South Buffalo, and Winfield townships, and at a point in the road about 1½ miles southwest of Coyleville, in Clearfield Township. This is probably the same as the Bakerstown coal described by I. C. White in southern Butler County.[b] It is not of sufficient importance to warrant further description.

Saltsburg sandstone.—Associated with the Bakerstown coal both above and below is a massive, coarse-grained sandstone whose limits are somewhat indefinite, but which is so prominent a feature in the southwestern part of the Kittanning quadrangle that it has been mapped as the Saltsburg member of the Conemaugh formation. There are 40 to 50 feet of sandstone below the coal and from 60 to 80 feet above it. The flat-lying land in the south western part of Winfield Township is formed by the upper sandstone. These two beds o sandstone are separated in places by a thin bed of shale containing the Bakerstown coal and fire clay. It is possible that this separation could be made throughout the part of the quadrangle in which the sandstones occur if exposures were good, but under present condi tions it is impossible to trace such a separating bed. The sandstone below the coal is clearly the same as the Buffalo sandstone of White,[c] and the upper occupies the position of the Saltsburg sandstone of Lesley.[d] It is believed, however, that the sandstone mass as a whole corresponds best with the Saltsburg sandstone in its type locality, and that name has been adopted.

The upper sandstone is the thicker and more conspicuous of the two. It occurs over all the area south of Rough Run and caps the high hill between Buffalo Creek and Sipes Run. The quarries on the hilltop at West Winfield are in this sandstone, which is here rather coarse and thick bedded. Besides its occurrence south of Rough Run the lower or Buffalo sandstone of White occurs over the area mapped along the West Winfield-Fenelton road. Along this road, 1½ miles north of the latter area, the Bakerstown coal occurs in the midst of shale, but the sandstone both above and below the coal has practically disappeared from the section. With a few possible exceptions these sandstones are not recognizable as such outside of the areas mapped. Where they are absent their place is occupied by sandy shale and occasionally by thin flags. Along the ridge road west of the river about 3 miles south of Weskit blocks of heavy sandstone occur which probably belong to this horizon. Near the

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[a] Maryland Geol. Survey, vol. 5, p. 304.
[b] Second Geol. Survey Pennsylvania, Rept. Q., p. 96.
[c] Op. cit., p. 33.
[d] Second Geol. Survey Pennsylvania, Rept. K3, p. 22.

tops of the higher hills in the northwest quarter of the Kittanning quadrangle, along the ridge road nearly east of Templeton toward Goheenville, and on the ridge south of Hays Run and eastward in Rayburn and Valley townships, a sandstone that is generally coarse and friable, yielding small débris, but which is sometimes hard, may represent the Saltsburg, since it lies about 160 to 200 feet above the Upper Freeport coal.

Red shale.—In the vicinity of Sistersville, close beneath the Ames limestone and about 300 feet above the Upper Freeport coal, lies a bed of red shale. This was not noted elsewhere in the Kittanning quadrangle, but in the Rural Valley quadrangle it occurs from Blanket Hill to the central part of Cowanshannock Township, and northward into Wayne Township on a number of hilltops about 250 feet above the Upper Freeport coal.

Ames limestone.—On a few high knobs in North Buffalo Township, north of Slate Lick and Sistersville, a thin limestone occurs. It has a grayish or greenish color and is often full of fossils, among which crinoidal stems are plentiful. It has been noted during the present survey at two points. One of these is the top of the knob east of the road one-half mile south of the head of Marrowbone Run and 1⅓ miles slightly northeast of Slate Lick. The other is the knob one-half mile northeast of Sistersville. It is known only by fragments on the surface, and these would indicate a thickness of about 1 foot. In the former locality the distribution of the fragments would indicate that the limestone occurs in two beds separated by almost 20 feet of shale, the lower being about 315 and the upper about 335 feet above the Upper Freeport coal; the horizon of this limestone passes through several other knobs in the southwest corner of the quadrangle and it may occur on them. Platt [a] reports it on a high knob about 1 mile northwest of Slate Lick. This limestone has been traced pretty continuously across southern Butler County by I. C. White [b] and found to be the same as the crinoidal limestone of Beaver County, with which it agrees in its fossiliferous character and its stratigraphic position, which ranges from about 290 feet above the Upper Freeport coal in the Beaver quadrangle to about 330 feet above the coal in the Kittanning quadrangle. This limestone is generally known as the Crinoidal limestone throughout western Pennsylvania, but for reasons already stated (p. 34) in connection with the description of the Vanport limestone, the geographic name Ames [c] has been substituted for the descriptive name Crinoidal.

Higher sandstones.—Along the southern margin of the Rural Valley quadrangle in Plum Creek and Cowanshannock townships a number of hills have a coarse, heavy sandstone cropping out near their summits or capping them. The sandstones at the various points are similar in lithologic character, but if the interpretation of the structure of the region, as made out from well records, is correct, they can not be regarded as belonging to the same stratum, since they vary in position from 220 to 450 feet above the Upper Freeport coal. It is possible that the higher of these sandstones is the Morgantown, since it occupies nearly the stratigraphic position of that stratum as it occurs in Fayette and Westmoreland counties.

QUATERNARY DEPOSITS.

CARMICHAELS FORMATION.

Character and distribution.—Along several of the tributaries of the Allegheny, and especially along Mahoning Creek, there are thin deposits of alluvium and stream-worn material consisting of pebbles and rounded bowlders of considerable size, at heights above the present streams from 20 feet on the headwaters of the Cowanshannock to 100 feet on the Mahoning. These deposits differ from those described in the next section chiefly in that they are of local derivation solely and contain no admixture of foreign material. The name was applied by Campbell (Masontown-Uniontown folio) to terrace deposits of local origin and of probable Kansan age along Monongahela River, which are particularly well developed at Carmichaels, above Brownsville. The name has been extended appropriately to embrace all deposits of like age and origin in the western part of the State, but it must not be inferred that the

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 287.
[b] Second Geol. Survey Pennsylvania, Rept. Q., p. 77, et seq.
[c] Andrews, Ohio Geol. Survey, vol. 1, pt. 1, pp. 235, 296.

deposits bearing this name are alike either in character, thickness, or mode of accumulation in the different localities.

A small area of these deposits occurs in Glade Run in the Kittanning quadrangle and on the northern bank of Redbank Creek near the boundary between the quadrangles. They occur at various points on Mahoning Creek to above Eddyville and are composed of distinctly stream-worn and water-laid material. On the north side of South Fork of Pine Creek they may reach a thickness of 10 feet, but they contain here much less distinctively water-worn material and more alluvium than on the Mahoning. On Cowanshannock and Plum creeks they are scarcely distinguishable from the soil of the hillsides or from the alluvium of the flood plains, but have been mapped largely on topographic grounds, since the low terraces along those streams apparently correspond to those on which the deposits occur on the other streams.

GRAVEL AND SILT OF GLACIAL DERIVATION.

Earlier deposits—character and distribution.—This material exists in the form of terraces along Allegheny Valley the tops of which lie from 200 to 250 feet above the river. It is composed of more or less well-stratified clay, sand, and gravel, reaching a maximum thickness of 70 to 75 feet at the mouth of Limestone Run and east of Manorville. The character of the deposit is well shown in a cut of the Buffalo, Rochester and Pittsburg Railroad near the mouth of Limestone Run, where it is exposed to a depth of at least 50 feet. The greater part of the deposit is medium to fine gravel with which there is more or less sand. A small proportion of the gravel consists of pebbles of crystalline rocks.

The largest area of this material occurs on the terrace east of Ford City. On the opposite side of the river is another area. Weskit is built on such a gravel terrace; another occurs on the hill just northeast of Kittanning; there are several terraces covered with this material along the west side of the river below the mouth of Limestone Run, and farther north on the same side of the river these deposits stretch from the mouth of Limestone Run to opposite Templeton. Nearly opposite the mouth of Redbank Creek is a narrow area, east of East Brady is another small patch, and on the north side of the river near the margin of the quadrangle is another.

Origin of deposits.—The origin of this material is explained as follows: The river at one time flowed about 200 feet higher in the rocks than it does at present and in that position had eroded a valley with a floor varying about one-fourth mile to 1¼ miles in width. This condition existed in the early stages of Glacial time. At this time great quantities of gravel and silt were transported by the ice from as far north as the areas of crystalline rocks of Canada, whence came the crystalline pebbles of the deposits. This transported material was scattered over the surface covered by the ice down to its southern margin, which extended down the river to the vicinity of Kennerdell. Great quantities of this material were washed into the river, carried downward, and deposited on the old river bed, filling the valley to a depth of 100 feet or more. Subsequently most of this material was washed out by the river and the present trench cut below the former river bed, leaving the terrace gravels lying on the valley walls where they now exist. In some cases gravels occur much lower on the slopes than described above. These lower gravels have either been washed down the slopes from their original position or have been redeposited by the river on its curves while deepening its valley.

Age of deposits.—The high-level gravel deposits described above are believed by Leverett to be at least as old as the Kansan deposits of the interior and perhaps older.[a]

Gravel of Wisconsin age.—Subsequent to the trenching of the river valley after the Kansan filling described above, the bottom of the valley was filled to a depth of about 50 feet with gravel and silt, which forms the present narrow strips of level land at various points along the river. The level ground forming the sites of Kittanning and Ford City is a good example of this material. It was brought into the valley during the latest or Wisconsin stage of glaciation in the same manner as the deposits of Kansan age, and has been subsequently trenched by the river, leaving the higher portions above the flood level.

[a] Mon. U. S. Geol. Survey, vol. 41, 1902, pp. 239 et seq.

ALLUVIUM.

This consists of fine material laid down by the present streams at times of overflow and is present to a greater or less width along most of the principal streams well up toward their headwaters.

MINERAL RESOURCES.

COAL.

GENERAL DISCUSSION.

As will be seen by the accompanying illustration (fig. 6) the area described lies in the northern end of the great bituminous coal field of eastern United States and coal is its most important source of mineral wealth.

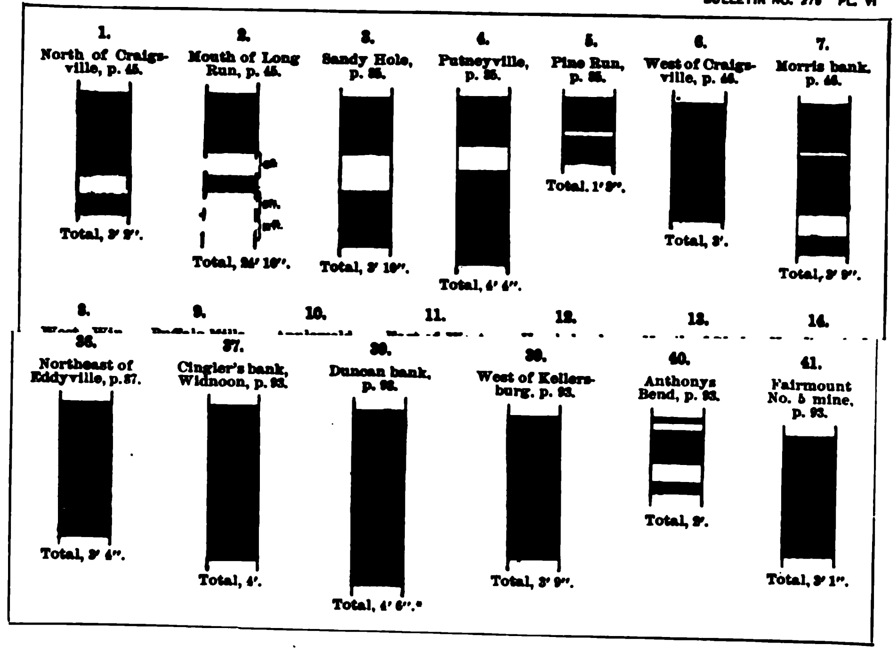
There are in all eight seams that reach minable thickness over areas of greater or less extent in the quadrangles. These are, in ascending order, the Brookville, Craigsville,

FIG. 6.—Map showing extent of the northern part of the Appalachian coal field.

Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, Upper Freeport, and Brush Creek seams. The first seven of these seams occur in the Allegheny formation, and the last in the Conemaugh formation. Their general stratigraphic relationships are shown in the generalized section (Pl. V), and are set forth in the preceding description of those formations.

Of the eight seams, only two, the Lower Kittanning and the Upper Freeport, are generally workable. The Lower Freeport comes next in importance, followed by the Upper Kittanning. The remaining four, so far as known, are minable only in small areas and with the possible exception of the Brookville coal along Upper Mahoning Creek, hardly rank as coals of commercial importance.

On the accompanying map (Pl. XI) where a seam is known to be of minable thickness or is regarded as probably such, its outcrop is shown by a full line; where it is not known *to* be minable but is possibly so, its outcrop is shown by broken lines. Where nothing is



COAL SECTIONS.

Sections 1 to 5, Brookville coal; section 6, Craigsville coal; sections 7 to 10, Clarion coal; sections 11 to 41, Lower Kittanning coal.

* Maximum thickness.

[illegible]

known of a seam, or it is known to be too thin to mine, its outcrop is not shown on the map. In most cases the mapping of the outcrop of coals between the Lower Kittanning and the Upper Freeport seams is based upon the blossom of these coals at a few points along the roads, and their value can be determined only by prospecting along these lines.

The description of the coals will be given separately for each of seven drainage basins as follows: Buffalo Creek, Glade Run, Allegheny River with its smaller tributaries, Redbank Creek, Mahoning Creek, Pine Creek, and Cowanshannock Creek. The position of a bank, prospect, or outcrop is indicated on the map (Pl. XI) by a cross (×), and the position of a mine by crossed hammers. Each point is numbered on the map and the corresponding number is inserted in the text in connection with the description of the coal at the given point. By this means it is possible to indicate the exact locality at which an observation was made. In many cases coals are noted in the records of deep wells and in describing these coals the name of the well will be followed by a number in parentheses, which is the map number of the well. In a few cases where sections are taken from Platt's Report II5, it is impossible to identify the exact point at which the section was obtained. All points are numbered consecutively for each seam from the mouths or lower parts of the streams toward their heads, and a general index to the numbers is given on the margin of the map.

In these quadrangles the roof of the coal seams is prevailingly a stiff shale which holds up well, and the floor is usually fire clay, a rock that can be removed in mining without great expense. In the sections given in the detailed description of the coals, it is to be understood that the roof is probably shale and the floor clay unless otherwise stated. Under these conditions any seam having a fairly regular thickness of 2 feet or over is considered minable.

COALS IN BUFFALO CREEK BASIN.

BROOKVILLE COAL.

In the Dumbaugh heirs' well (183) near State Lick a coal is reported 464 feet deep and 4 feet thick that may be Brookville. This coal was once opened on the Nickels farm opposite the mouth of Long Run, as reported by Platt.[a] There is an abandoned bank in this locality, No. 1 on Pl. XI, which may be the one noted. The coal is broken by shale partings in such a manner as to be of little value, as shown by the following section:

Brookville coal at Nickels bank, opposite the mouth of Long Run, No. 1 (Pl. VI, 1).

	Ft.	in.
Coal	1	9
Shale		1
Coal		3
Shale		7
Coal		6
	3	2

A cut on the Buffalo, Rochester and Pittsburg Railroad, a short distance east of where it crosses the highway at the mouth of Long Run, No. 2, reveals the following section:

Brookville coal in railroad cut at mouth of Long Run, No. 2 (Pl. VI, 2).

	Ft.	in.
Bony coal	1	6
Sandy shale	8	
Coal		4
Shale	5	..
Sandstone (Homewood?)	10	..
	24	10

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 279.

The coal in this section is probably the Brookville, and its worthlessness is evident. On the road running north from Patterson Creek to Fosters Mills, No. 3, coal blossoms were noted, one of which is probably made by the Brookville seam, but nothing is known of its thickness.

CRAIGSVILLE COAL.

In the description of the Allegheny formation (p. 32) the name Craigsville is used for a coal in the vicinity of Craigsville between the Brookville and Clarion coals. The reasons for regarding this as a distinct seam are fully set forth in that discussion. At a bank near the road northward from Buffalo Creek, about 2 miles west of Craigsville, No. 4, this coal is 3 feet thick (Pl. VI, 6). On the hill about 1 mile northwest of Craigsville, No. 5, is an old opening in what appears to be this coal, which is reported 3 feet 6 inches thick, and apparently the same coal makes a good showing south of Patterson Creek along the road between Craigsville and Fosters Mills, No. 6. Judging from these indications, it is possible that there is a considerable body of workable coal in this seam northwest of Craigsville. This can be determined, however, only by thorough prospecting.

CLARION COAL.

The Clarion coal is mined to some extent by A. G. Morris at West Winfield, No. 7, where the seam reaches a good thickness, though it is divided into three benches by two shale partings. The following section was measured by the writer at this bank:

Clarion coal at the A. G. Morris bank, West Winfield, No. 7 (Pl. VI, 7).

	Ft.	in.
Coal	1	2
Shale		½-1½
Coal	1	6
Shale		7
Coal		5
	{ 3	8½
	to 3	9½

Analysis No. 1 of the table on page 98 is of a sample from this bed. Platt [a] published the following section from this place, though possibly not from the same bank:

Clarion coal at West Winfield (Pl. VI, 8).

	Ft.	in.
Coal	1	1
Shale		1
Coal		6
Shale		1
Coal		9
	2	6

This coal was also exposed in prospecting for the Clarion clay at the Duquesne Fireproofing Company's works, No. 8 on Pl. XI, and reported 2 feet 6 inches thick. The Clarion coal is believed to occur in the following wells on Buffalo Creek southeast of West Winfield:

Clarion coal in wells on Buffalo Creek.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
Pump station (171)	20	4
T. J. Ewing No. 2 (172)	305	5
Ralston heirs No. 1 (170)	410	3

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 291.

At the roadside just below Buffalo Mills, No. 9 on Pl. XI, the following section is exposed and exhibits the worthless character of the coal:

Clarion coal below Buffalo Mills, No. 9 (Pl. VI, 9).

	Ft	in.
Coal		6
Shale	1	0
Coal		6
Shale		2
Coal		10
Shale		1
Coal		2
	3	3

About 2 miles above Craigsville, No. 10, this coal is reported to be 2 feet thick. It is not known elsewhere on Buffalo Creek.

LOWER KITTANNING COAL.

The Lower Kittanning coal has been worked to some extent on Buffalo Creek east of West Winfield, and it is known or reported at a number of points. There is an opening at No. 11, where the coal is 3 feet 8 inches thick (Pl. VI, 11). In the T. J. Ewing well No. 2 (172), the Lower Kittanning is reported 5 feet thick and 145 feet deep. At the Blane bank near creek level 1½ miles east of West Winfield, No. 12, the coal is 3½ to 4 feet thick. In the Blane well near by this coal is reported 4 feet thick and 75 feet deep, and in the Fink well, No. 2 (180), situated near the mouth of a ravine just above the Blane bank, the coal is reported 3 feet thick and 39 feet deep. At an opening in the southwest corner of West Franklin Township, No. 13, the coal is 2 feet 5 inches thick. In the northwest corner of Winfield Township, No. 14, the Lower Kittanning coal has been stripped, but at the time this survey was made it was not exposed to observation. In the general region of Buffalo Mills and farther south the coal is usually good. Near Buffalo Creek, about 2 miles below Buffalo Mills, No. 15, is a working bank, and in an opening 1½ miles southwest of Buffalo Mills, No. 16, the coal was 2 feet 8 inches thick. On the Peter Graff property, at Buffalo Mills, Nos. 17 and 18, Platt[a] reports the coal 3 feet 6 inches thick on the average. The seam contains here, 1 foot 6 inches from the floor, a persistent binder 6 inches to 1 foot thick and thinner and less persistent bands below. The coal from the upper part of the seam is the best and, it is claimed, produces a high heat. It was once used for fuel in the woolen mill and for burning lime. At old openings just north of the Butler pike midway between Buffalo Mills and Coyleville, Nos. 19 and 20, the coal is reported 3 feet 8 inches thick. (See analysis No. 3, p. 98). The coal has been opened at other points in this vicinity, Nos. 21 and 22. At Bowser's bank, No. 23, 1 mile north of Buffalo Mills, the coal is 3 feet 8 inches thick. A sample of coal from this bank was analyzed with the result shown in analysis No. 6 (p. 98). At a bank on the D. S. Hawk farm, No. 24, the coal has the following section:

Lower Kittanning coal at the D. S. Hawk bank, No. 24, Long Run (Pl. VI, 12).

	Ft.	in.
Coal, shaly		6
Coal	2	6
Coal, shaly		6
	3	6

At an opening on the north side of Long Run, No. 25, the coal was 2 feet 6 inches thick, and at a bank one-half mile above, No. 26, the coal is 3 feet 6 inches thick. Just above are two other openings, No. 27. In the vicinity of Fosters Mills are a number of old openings, Nos. 28 and 29, where the coal is reported by Platt[b] to average 3 feet in thickness. In this vicinity it is closely overlain by a coarse sandstone. Near Craigsville and Nichola

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 281.

[b] Op. cit., p. 278.

are several old openings. In old pits near the top of the hills west of Craigsville, Nos. 30 and 31, the coal was reported 2 feet 6 inches thick. At an opening on the hill 1 mile northwest of Craigsville, No. 32, the coal runs from 2 feet to 2 feet 6 inches thick, and in a working bank three-fourths mile west of Nichola, No. 33, the coal varies from 2 feet 6 inches to 2 feet 10 inches in thickness. In the immediate vicinity of Nichola the coal has been opened at three points, Nos. 34, 35, and 36. At No. 35 its thickness varies from 3 to 4 feet. The Lower Kittanning coal is below water level on both streams a short distance above Nichola and is not elsewhere exposed in this basin. It is reported of good thickness in a number of wells in the northern part of the Buffalo Creek basin, as shown below.

Lower Kittanning coal in wells in Buffalo Creek basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Michael Maley No. 1 (75)	103	4	Pontius No. 1 (110)	325	3
Goldlinger No. 2 (76)	284	4	John Patton (233)	58	4
Goldlinger No. 1 (77)	320	4	Scott Hepler (234)	140	4
John King No. 4 (86)	192	....	John Adams (236)	215	4
King No. 3 (87)	226	4	James Henry (232)	140	4
King No. 2 (88)	292	4	Keener (226)	100	4
A. Black No. 1 (102)	296	....	J. B. Neal (274)	269	3
Pontius No. 3 (105)	265	....			

MIDDLE KITTANNING COAL.

There is considerable evidence of the presence of the Middle Kittanning coal in the vicinity of West Winfield. It is exposed in a cut of the West Winfield Railroad three-fourths mile below the mouth of Rough Run, No. 37, and there is an old opening in it by the highway on the opposite side of the creek, No. 38. At No. 37 the coal as seen from the highway opposite appears to be from 2 to 3 feet thick. The blossom of what is regarded as this coal shows at points Nos. 39 to 41, north of West Winfield. Southwest of Buffalo Mills its blossom was observed at two points, Nos. 42 and 43, and 1 mile northwest of Buffalo Mills it shows in the road at No. 44. Along the Buffalo, Rochester and Pittsburg Railroad on Long Run, No. 45, the coal shows as a thin seam. In the road west of the head of Long Run, and about 1½ miles west of Cowansville post-office, No. 46, the coal had been stripped and is 2 feet thick. The blossom of this seam was seen in the road about 1½ miles south of Fosters Mills, No. 47, and there is an old opening in it 1 mile northeast of Fosters Mills, No. 48. Along Buffalo Creek between Craigsville and Fenelton this coal appears to be thicker than usual, and may be of economic importance. At an opening on the hill 1¼ miles northwest of Craigsville, No. 49, the coal is 2 feet 1 inch thick.

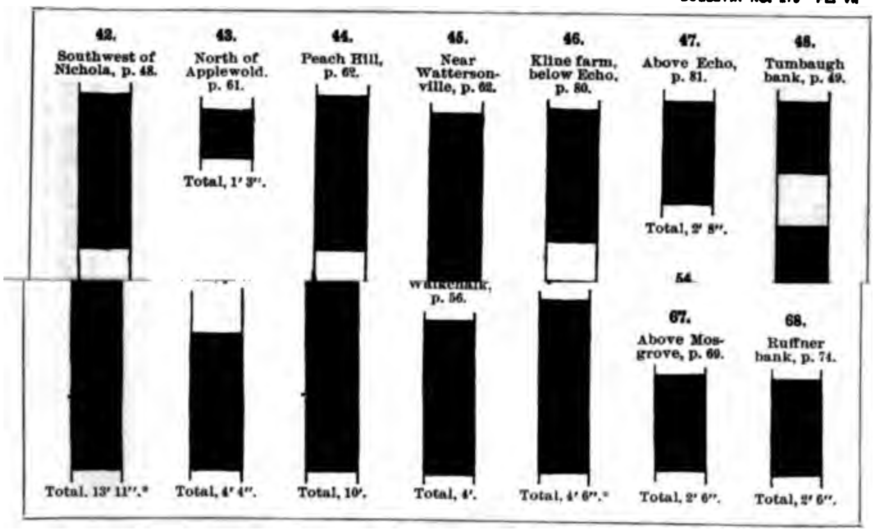
I. C. White[a] published the following section of a coal which he regarded as the Lower Kittanning, but which is more probably Middle Kittanning:

Middle Kittanning coal south of Buffalo Creek, 1½ miles southwest of Nichola, No. 50 (Pl. VII, 42).

	Ft.	in.
Coal	4	
Slate	1	6
Coal	2	6
Shale		3
Coal	2	6
	10	9

In mining, the upper 4 feet is left for roof. The lower benches are excellent coal. The exact locality of the opening at which this section was obtained is not clear from White's

[a] Second Geol. Survey Pennsylvania, Rept. Q., p. 138.



COAL SECTIONS.

Sections 42 to 47, Middle Kittanning coal; sections 48 to 61, Upper Kittanning coal; sections 62 to 68, Lower Freeport coal.

* Maximum thickness.

description, but it seems to be in a little run entering Buffalo Creek from the south about 1 mile west of the county line, in the vicinity of point No. 50. From the known position of the Lower Kittanning coal at No. 33, from the reported position of the Vanport limestone at water level at the bridge below No. 33, and from the westward dip that prevails in the region, it seems impossible to accept White's identification of this coal as the Lower Kittanning; moreover, its section is entirely different from that of the Lower Kittanning in the vicinity. On the opposite side of Buffalo Creek, No. 51, is an old opening, now closed, in the same coal, which is reported 6 feet thick. On the south side about one-half mile higher up the creek, No. 52, is another old pit in which the same thickness is reported. If the above identifications are correct, there is in this region a considerable area of Middle Kittanning coal of workable thickness.

UPPER KITTANNING COAL.

What appears to be the Upper Kittanning coal is recorded in the R. Z. McClatchey well (169) 400 feet deep and 5 feet thick, and in the T. J. Ewing well No. 2 (172) 305 feet deep and 5 feet thick. At an old opening in this coal, No. 53, 1½ miles east of West Winfield, the indications are that it is of no value. Coal blossoms believed to be Upper Kittanning show at a number of points in the southwest part of the Buffalo basin as follows: In the road one-half mile south of West Winfield, No. 54; in the road along Rough Run 1 mile south of the Winfield-Clearfield boundary, No. 55; in the road 1½ miles north of West Winfield, No. 56, and in the road nearly 1 mile east of the latter point, No. 57. All of these exposures are of small extent. In the road in the southeast corner of Clearfield Township, No. 58, the coal is exposed 2 feet thick, and at No. 59 in the same locality it makes a good showing. In the M. Weiland well (55) what may be this coal is reported 12 feet thick at a depth of 310 feet. In the region surrounding Buffalo Mills the presence of this seam is indicated by its blossom at several points, Nos. 60 to 64. At No. 62 southwest of Buffalo Mills and at Nos. 63 and 64, northeast of Buffalo Mills, the showing is good. Near the head of a little ravine almost on the boundary between East and West Franklin townships, No. 65, is an old opening, which is possibly that of the Tumbaugh bank, where Platt[a] obtained the following section:

Upper Kittanning coal at the Tumbaugh bank, Long Run, No. 65 (Pl. VII, 48).

	Ft.	in.
Coal	1	10
Shale and fire clay	1 to 1	4
Coal	1 to 2	10 10
	4 to 5	8 2

In the J. B. Neal well (274), in the northwest corner of West Franklin Township, this coal was reported 2 feet thick and 140 feet deep. What is regarded as the blossom of this coal occurs in the road where it crosses the head of Long Run between Cowansville and Browns Crossroads, No. 66. Along the streams from Nichola to Rattigan, and to Fenelton, the Upper Kittanning coal appears to be fairly well developed. Its blossom was seen in the road south of Buffalo Creek in the eastern part of Clearfield Township, Nos. 67 and 68, and north of the creek, No. 69, is an opening in which the following measurement was obtained:

Upper Kittanning coal 1 mile east of Fenelton, No. 69 (Pl. VII, 49).

	Ft.	in.
Sandstone roof		
Coaly shale		9
Coal	2	2
	2	11

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 283.

The seam here is very irregular in thickness; in one place the sandstone roof cuts out its upper portion and reduces it to 8 inches. In the northeast corner of Clearfield Township, No. 70, this coal was reported 4 feet thick in an old pit; in the southeast corner of Donegal Township, No. 71, its blossom shows in the road, and about one-half mile north of the latter point, No. 72, is another old opening, probably in this coal. In well No. 118 (90) on the Bradys Bend tract, 1 mile west of Rattigan, the Upper Kittanning is recorded 2 feet thick at a depth of 60 feet, and in the Pontius well, No. 1 (110), in northern Donegal Township, it is reported 4 feet thick at a depth of 259 feet.

LOWER FREEPORT COAL.

In the Charles Myers well (167) southeast of Slate Lick what appears to be the Lower Freeport coal is reported 5 feet thick, at a depth of 250 feet, and in the Rayburn heirs No. 1 well (182), north of Slate Lick, it is reported 4 feet thick and 145 feet deep. North of Rough Run and about 1 mile west of West Winfield, No. 73, this coal was reported 2 feet 8 inches thick by parties sinking a prospect hole for iron ore. Its blossom at points in southern Clearfield Township, Nos. 74 to 76, indicates a thickness of 2 feet. In the southwest corner of West Franklin Township a thin blossom was seen at No. 77 and at No. 78 the coal makes a good showing and may be 2 or more feet thick. This coal was noted in the following wells in southern West Franklin Township:

Lower Freeport coal in wells in West Franklin Township.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
M. E. Smith (213)	30	4
Lesley Long (221)	100	....
S. B. Claypool (222)	170	4

Along the western margin of West Franklin Township the Lower Freeport coal makes a good showing at several points, Nos. 79 to 84, and may be of minable thickness. In the vicinity of Fenelton what is presumably this coal has been opened just east of the station, No. 85, and its blossom shows in the road a short distance west of Fenelton, No. 86. In southeastern Donegal Township the coal is of such thickness that it has been worked at several points. At No. 87 its blossom was seen, at No. 88 is an old opening, and in the vicinity of Rattigan, Nos. 89 to 91, the blossom shows. West of Buffalo Run is a working bank, No. 92, and in the road just west of Buffalo Bridge, No. 93, the coal is apparently 3 to 4 feet thick. It also makes a good showing in the road about one-half mile farther west, No. 94, at which point it is closely overlain by the Butler sandstone, which yields the large blocks so conspicuous in that vicinity. Still farther up the little run to the northwest the coal has been opened at several points, Nos. 95 to 97, and its blossom was noted at Nos. 98 and 99. At No. 95 considerable coal has been taken out, judging from the waste still remaining about the pit mouth. About 1 mile northwest of Rattigan, No. 100, is an old opening in what is probably this coal. In the Pontius well No. 1 (110) the Lower Freeport coal is penetrated at a depth of 142 feet, and reported 8 feet thick, which is of course an exaggerated estimate. Over a considerable territory between Worthington and Cowansville this coal is of good thickness. About 1 mile north of Worthington, No. 101, what appears to be the Lower Freeport coal has been opened under a coarse sandstone. Two miles northeast of the latter point, No. 102, the blossom of the coal appears in the road, and still farther northeast, No. 103, the coal is cut through in the tunnel of the Buffalo, Rochester and Pittsburg Railroad, and shows the following sections:

Lower Freeport coal in the Buffalo, Rochester and Pittsburg tunnel, No. 103 (Pl. VII, 62).

	Ft.	in.
Coal	1	6½
Shale		1
Coal	2	8½
Clay	2	6
Coal		9
	7	7

While this is a great thickness for a coal seam in this region, only 4 feet 4 inches of it is available for mining. Northward along the road through Cowansville, Nos. 104 to 106, are openings which show that this coal is of minable thickness over a considerable area. The bank at No. 105 is now worked, the others are closed. One-half mile south of Fosters Mills, No. 107, a few fragments of coal were noted which indicate the presence of this seam. On the road between Browns Crossroads and Cowansville indications of this coal were seen at points Nos. 108 and 109, and about 2 miles northwest of Fosters Mills, No. 110, the coal shows in the road.

UPPER FREEPORT COAL.

The Upper Freeport coal is generally of good thickness in the Buffalo basin, though there are exceptions to the rule. It was noted in well records in the southern part of the quadrangle as follows: Casper Freehling No. 3 (2), 250 feet deep; Painter heirs (4), 200 feet deep. In both it is reported 3 feet thick. It crops out near the base of the hills along Cornplanter Run and is closely overlain by the Mahoning sandstone, which is said to cut out the coal to such an extent as to render mining unprofitable. The coal has been opened at several points on the last-mentioned stream, Nos. 111 to 113. At No. 111 it was 3 feet thick, at No. 112 over 2 feet thick, and at No. 113 it is reported 1 foot 6 inches thick. There are a number of old banks in the vicinity of Boggsville, Nos. 114 to 116, but nothing was learned of the thickness or quality of the coal. Above the road three-fourths mile north of Boggsville, No. 117, the coal has been opened and is 2 feet thick (Pl. VIII, 75), and on the west side of Buffalo Creek, No. 118, it makes a good showing in the road. The Upper Freeport coal is noted in a number of wells in the southern part of this basin, as shown below:

Upper Freeport coal in wells in Buffalo Creek basin.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
Charles Myers (167)	193	3
J. Weaver No. 1 (168)	255	4
Lewis Baker (174)	135	4

This coal is generally of a good thickness where exposed in western North Buffalo Township. On Marrowbone Run, No. 119, the following section was measured:

Upper Freeport coal on Marrowbone Run, No. 119 (Pl. VIII, 76).

	Ft.	in.
Coal		8
Coal	2	6
	3	2

The coal is here underlain by fire clay and that in turn by the Upper Freeport limestone, which appears to be pure and of good thickness. It is also closely overlain by the Mahoning sandstone which is coarse and 20 feet thick. At Beatty's mill, No. 120, the coal is 3 feet thick and shaly (Pl. VIII, 77). The shaly coal bench of the section on Marrowbone Run seems to have thickened so as to include the whole seam in the Beatty's mill section At

this point the limestone below the coal is 3 to 4 feet thick. On the Meals farm in this locality Platt [a] obtained the following section of this coal:

Upper Freeport coal on Meals farm, Buffalo Creek (Pl. VIII, 78).

	Ft.	in.
Shale		6
Coal	3 to 4	6 0
	4 to 4	0 6

The seam at this point is overlain by 20 feet of sandstone. Platt regarded this coal as Lower Freeport, but its thickness and stratigraphic relations indicate rather that it is the Upper Freeport. The coal makes a good showing in the shale cut by the highway on the point overlooking Buffalo Creek 1 mile southwest of Beatty's mill, No. 121. Its blossom was observed on the road to the north, No. 122, and fragments of coal probably from this seam were found in the sand of the road bank south of the bridge over Buffalo Creek, No. 123. The Upper Freeport coal is generally of good thickness in the uplands along Rough Run. A good blossom was observed in the road eastward over the hill from the junction of Rough Run and Buffalo Creek, No. 124, and also in the road running southwest over the hill from West Winfield, No. 125. There is an old opening near the next road south from Rough Run, No. 126, and one-half mile farther west is a working bank on the Heim farm, No. 127, at which the following section was obtained:

Upper Freeport coal at Heim bank, No. 127, south of Rough Run (Pl. VIII, 79).

	Ft.	in.
Shaly coal		6
Coal	2	7
	3	1

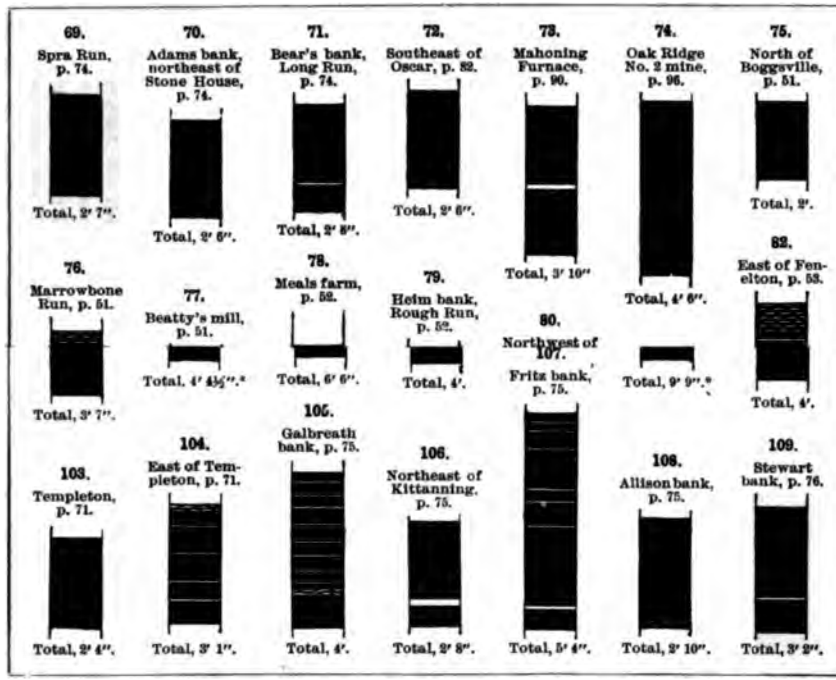
On the little run south of Rough Run, 1 mile east of the quadrangle boundry, is the John Green bank, No. 128, at which the coal was reported 2 feet 10 inches thick. Just south of the Green bank is another, No. 129, from which considerable coal is taken. There are a number of other openings in this vicinity where the coal is of fairly good thickness. On the hilltop north of West Winfield, No. 130, the coal was opened and a thickness of 1 foot 6 inches was exposed. The opening was not driven under rock cover, however, so the coal may be thicker. Still farther to the west, near the second road north from Rough Run there is an old opening, No. 131, and a short distance farther west along the hill, No. 132, the coal is 2 feet thick (Pl. VIII, 80). About 2 miles northwest of West Winfield the coal is opened on the Laurence Denny farm, No. 133, and shows the following section:

Upper Freeport coal at the Denny bank 2 miles northwest of West Winfield, No. 133 (Pl. VIII, 81).

	Ft.	in.
Shaly coal	1	
Coal	2	3
	3	3

At the head of a western branch of Rough Run near the edge of the Kittanning quadrangle, No. 134, the coal makes a good showing, as also in the road crossing the head of the run in southern Clearfield Township, Nos. 135, 136. Nearer the southeast corner of Clearfield Township, No. 137, the coal makes another small showing. In southwestern West Franklin Township, No. 138, the coal was opened at one time, but nothing could be learned of its thickness or character. At other points in this region, Nos. 139 to 141, the blossom of the coal was noted. While it is evidently present on the hilltops of this region, it is in small patches, and its thickness and character are not known. In the Lesley Long well

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 285.



COAL SECTIONS.

Sections 69 to 74, Lower Freeport coal; sections 75 to 109, Upper Freeport coal.

* Maximum thickness.

(221), 1½ miles south of Worthington, the Upper Freeport coal was noted at a depth of 40 feet, and in the S. B. Claypool well (222), 1 mile southeast of the Long well, it was penetrated at a depth of 130 feet and was reported 3 feet thick. In the vicinity of Worthington, Nos. 142 to 145, the blossom of what is regarded as this coal was noted, and an old opening in the same was reported in the village, No. 143. At all these points the indications are that the coal is thin. In the eastern part of Clearfield Township the coal was once opened and worked on the McGucken farm, No. 146, and it is reported 3 feet thick. One mile north of this farm a good blossom was noted just south of the Butler pike, No. 147, and north of the pike, No. 148, an old bank was reported from which considerable coal was once taken. In the M. Weiland well (55), southwest of Coyleville, the Upper Freeport coal was penetrated at a depth of 170 feet and reported 4 feet thick, and in the McShane No. 4 well (56), on the margin of the quadrangle about 1 mile northwest of the Weiland well, the coal was reported 188 feet deep and 5 feet thick. West of Fenelton there are a number of old banks in this coal, Nos. 149 to 151. At No. 151 the coal is reported 1½ feet thick. One-half mile southeast of Fenelton, No. 152, the coal is reported 4 feet thick at an old opening, and on the opposite side of Buffalo Creek, No. 153, the following measurement was obtained:

Upper Freeport coal one-half mile east of Fenelton, No. 153 (Pl. VIII, 82).

	Ft.	in.
Shaly coal		9
Coal with thin partings of shale	3	9
	4	6

About three-fourths mile north of Fenelton is a working bank, No. 154, and another that has been abandoned, No. 155. At the former the following section was measured:

Upper Freeport coal three-fourths mile north of Fenelton, No. 154 (Pl. VIII, 83).

	Ft.	in.
Coaly shale	1	7
Coal with thin partings	1	
Coal	1	
Coal with thin partings	1	
Coal		8
	5	3

In southern Donegal Township, just west of Buffalo Run, are old openings at Nos. 156 and 157. About 1 mile south of Rattigan there are a number of old openings, Nos. 158 to 164. The coal is reported 3 to 4 feet thick. One-half mile west of Rattigan the coal shows in the road, No. 165, and is 1 foot thick or over. Still farther west, No. 166, a good showing was noted, and about 2 miles north of the latter point, No. 167, the coal also makes a small showing. Along the road south of Chicora are two working banks, Nos. 168 and 169. At the latter the coal was reported 4 feet thick. In the vicinity of Chicora and northward toward Karns are a number of old workings, Nos. 170 to 180. Unfortunately no information was obtained about the coal at these points, but the number of workings indicates that it is probably of good thickness. About 1 mile northeast of Chicora, No. 173, the coal makes a good showing, and is probably 4 feet thick. North of Rattigan the blossom of this coal was noted at Nos. 181 and 182, and still farther north, in eastern Donegal Township, are two old openings, Nos. 183 and 184. East of the latter point, near the western margin of Sugar Creek Township, its blossom was observed, No. 185. In the Michael McCray well (242), in western Sugar Creek Township, this coal was recorded 30 feet deep and 5 feet thick, and in the Pontius No. 1 well (110), just across the boundary of Donegal Township, it was penetrated at the depth of 130 feet, being reported 2 feet thick. According to all reports and indications the coal is thin over a considerable area along the county line north of Rattigan. It was reported to the writer that efforts had been made in this region to obtain coal for fuel in the early days of drilling for oil, but

without success. On the McCue farm, in southwestern Sugar Creek Township, which the writer is unable to locate, Platt[a] secured the following section of the Upper Freeport coal:

Upper Freeport coal on McCue farm, in southwestern Sugar Creek Township (Pl. VIII, 84).

	Ft.	in.
Coal	2	1
Slate		1
Coal	1	7
	3	9

McCue's ravine was said to lie west of the Catholic Church, and it is possible that the bank referred to by Platt was the one by the roadside north of the church, No. 186. Northeast of the church are two old openings, Nos. 187 and 188. On the hilltop one-half mile north of Fosters Mills, No. 189, is an old opening that may be Wilson's bank referred to by Platt,[a] who reports the coal here 3 feet 6 inches thick, but shaly and impure. Southwest of Adams are two old openings, Nos. 190 and 191, one of which may be the opening in McElroy's ravine referred to by Platt.[b] He reported the coal at this bank as irregular in thickness, varying from 1 foot 6 inches to 4 feet. One mile south of Adams, No. 192, a small blossom of the coal was seen, as also at two points about 1 mile southwest of Adams, Nos. 193 and 194. At Adams the coal makes a good showing in the road, No. 195, and is 3 to 4 feet thick.

Along the road between Worthington and Cowansville, about three-fourths mile west of the tunnel, No. 196, the coal makes a good showing in the road, and is said to have been opened in an adjacent field, where it is 4 feet 6 inches thick. Near the road, almost directly over the railroad tunnel, No. 197, the coal was measured in a bank and found 4 feet 2 inches thick, with a few thin partings up to one-fourth inch in thickness (Pl. VIII, 85). Just south of the tunnel is an old opening, No. 198, at which the coal is reported 4 feet 6 inches thick. In the J. B. Neal well (274) already referred to (p. 49) the Upper Freeport is 55 feet deep and 4 feet thick.

BRUSH CREEK COAL.

The Brush Creek coal shows at many points between Boggsville and Worthington, but as it is of no commercial importance in the region it will not be described in detail. In order to enable the reader to identify the seam, however, a few points at which it is exposed are indicated by Nos. 199 to 206. At No. 200 it has been worked by the owner, Mr. Stonecipher, who said that he had taken out several hundred bushels of good coal. At No. 204 it has also been worked. At 206 only the black shale that usually accompanies the seam is present and is here 20 feet thick.

COALS IN GLADE RUN BASIN.

LOWER KITTANNING COAL.

The Lower Kittanning coal is exposed only at the mouth of Glade Run, where there is an old opening, No. 207, which may be the Bruner bank, at which Platt[c] obtained the following section:

Lower Kittanning coal at Bruner bank, No. 207, near the mouth of Glade Run (Pl. VI, 13).

	Ft.	in.
Coal, bony		3
Coal	1	5
Slate		1
Coal	1	6
	3	3

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 278. [b] Op. cit., p. 277. [c] Op. cit., p. 259.

This seam was said by Platt to yield but little good coal at the Bruner bank. The Lower Kittanning coal was noted in a number of wells in North Buffalo and East Franklin townships as follows:

Lower Kittanning coal in wells in Glade Run basin.

Name of well.	Depth.	Thickness.
	Feet.	*Ft. in.*
John Miller (186)	362	9
W. J. Bowser (193)	280	4
David R. Bowser No. 2 (207)	60	5
J. B. Drake (258)	235	3 3
J. H. Guthrie (260)	205	4
J. A. Patton (261)	235	6

MIDDLE KITTANNING COAL.

The horizon of the Middle Kittanning coal is exposed only near the mouth of Glade Run, and little is known of it in the area. The blossom of what may be the seam was observed at North Buffalo post-office, No. 208. It is reported in the logs of the following wells along Glade Run:

Middle Kittanning coal in wells in Glade Run basin.

Name of well.	Depth.	Thickness.
	Feet.	*Ft. in.*
Samuel Gray (191)	282	5
Ellermeyer (255)	200	4
J. B. Drake (258)	126	2 1
J. H. Guthrie (260)	155	3

UPPER KITTANNING COAL.

The horizon of the Upper Kittanning coal is exposed from the southern boundary of the quadrangle to one-half mile south of Walkchalk, where it goes under the surface and continues below to about 1 mile south of Cowansville station. What is probably its blossom shows in the road west of North Buffalo, No. 209. Still farther north, No. 210, the seam makes a good showing and has an apparent thickness of 2 feet. Its blossom was noted on the east bank of the run 1½ miles northeast of McHaddon, No. 211. In the J. B. Drake well (258) it was penetrated at a depth of 112 feet, and is 2 feet 4 inches thick. At the road crossing about 1 mile south of Walkchalk, No. 212, the seam is exposed in the road near creek level, and is 1 foot 6 inches thick. The coal seam is at creek level one-half mile south of Walkchalk, No. 213, where, according to report, it was once stripped from the creek bed. It is next noted south and southeast of Cowansville station, at No. 214, where it makes a good showing and is probably over 2 feet thick, and at Nos. 215 and 216, where only fragments were noted. It was apparently in the vicinity of the latter point, No. 216, that Platt [a] obtained the following section of what he regarded as Upper Kittanning coal:

Upper Kittanning coal at A. Milliken's, south of Cowansville (Pl. VII, 50).

	Ft.	in.
Coal	2	3
to	2	6
Slate	1	
to	1	3
Coal	3	4
	6	7
to	7	3

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 267.

It seems possible that in this case Platt mistook the Lower Freeport for the Upper Kittanning coal, since the above section is much like that of the Lower Freeport of that locality. North of Cowansville post-office, at the head of Glade Run, in southwestern Washington Township, No. 217, there is an old opening in what is probably this seam.

LOWER FREEPORT COAL.

The Lower Freeport is an important coal in the Glade Run basin, especially in the vicinity of Cowansville. Near the mouth of the run little is known of the coal. About one-half mile north of North Buffalo, No. 218, it outcrops in the road and appears to be 1 foot 6 inches thick. Farther north it makes a good showing in the road on the right bank of the stream, No. 219, and a little farther upstream, on the opposite bank, No. 220, its presence is indicated by fragments. In the W. C. Barnett well (200) the Lower Freeport coal is 72 feet deep and 1 foot 9 inches thick, and in the T. H. Allison well (211), about 1 mile north of the Barnett well, it is 22 feet deep and 1 foot 6 inches thick. In the road from Weskit to McHaddon, No. 221, a small blossom was noted, and a short distance south of this point, No. 222, the coal is exposed in a bluff and is 2 feet thick. It is here overlain by 25 feet of shale, and the sandstone so prominent at Walkchalk has disappeared from the section. In southwestern East Franklin Township the Lower Freeport coal is of good thickness, and has been worked to a considerable extent. It is worked on the Toy farm, No. 223, and near by is another opening, No. 224. At the latter opening the coal is 2 feet 6 inches thick, and in the Toy bank it shows the section below:

Lower Freeport coal at Toy bank, East Franklin Township, No. 223 (Pl. VII, 63).

	Ft.	in.
Coal with thin partings	2	3
Coal with shale partings up to one-half inch	1	
	3	3

In the Samuel Gray well (191), about 1 mile northwest of McHaddon, the coal is reported 160 feet deep and 5 feet thick, and in the Thomas Hays No. 1 well (253), about 2 miles south of Walkchalk, the coal is 95 feet deep and 3 feet thick. Northward along Glade Run to Walkchalk the Lower Freeport coal has been opened and worked to a considerable extent. A little more than 1 mile south of Walkchalk are abandoned openings, Nos. 225 to 226, and a working bank, No. 227, in which the coal was reported to be troubled with rolls, which rendered mining difficult and expensive. In the J. B. Drake well (258) the coal is 77 feet deep and 4 feet thick, and in the W. P. Bowser well (259), south of Walkchalk, it is 257 feet deep and 3 feet 7 inches thick. At Walkchalk are two openings, Nos. 228 and 229. At No. 229 the coal is 4 feet thick (Pl. VII, 64), and immediately overlain by the Butler sandstone, which is coarse and heavy throughout this vicinity. In the J. A. Patton well (261), about 2 miles northwest of Walkchalk, the Lower Freeport is reported at a depth of 60 feet. About 1 mile to the southeast and east of Cowansville station the coal shows well. At No. 230 it is exposed in the road, and is apparently 3 to 4 feet thick. At No. 231 the blossom of the coal was seen, and in the railroad cut 1¼ miles northeast of the station, No. 232, it is about 4 feet thick. At the Cowansville Mining Company's mine, No. 233, the seam is 4 feet to 4 feet 6 inches thick (Pl. VII, 65). Analysis No. 17 of the table on page 98 is of a sample from this mine. The seam is also of good thickness at the east portal of the tunnel southwest of Cowansville, No. 234.

UPPER FREEPORT COAL.

The Upper Freeport seam is present and generally of good thickness in the Glade Run basin except in the vicinity of Cowansville, where it is thin. Near the southern margin of the quadrangle are two openings, Nos. 235 and 236. No. 235 is the J. S. Bruner bank, in which the coal has the following section:

Upper Freeport coal at the J. S. Bruner bank, No. 235, southwest of North Buffalo.

	Ft.	in.
Coal	1	4
Shale		6
Coal	1	6
	3	4

The coal at this bank has an unusually high percentage of ash, as shown by analysis No. 21 of the table on page 98. One-half mile west of North Buffalo post-office, No. 237, is an old opening, and in the next ravine, one-half mile farther west, in the Claypool bank, No. 238, the following section was measured:

Upper Freeport coal at Claypool bank, west of North Buffalo, No. 238 (Pl. VIII, 86).

	Ft.	in.
Coal	1	4
Shale		2
Coal		3
Shale		6
Coal	1	6
	3	9

On Nicholson Run the coal has been opened at many points, and is probably of good thickness. Nos. 239 and 240 are working banks.

In the vicinity of Sistersville and McHaddon the Upper Freeport coal is reported in several wells as follows:

Upper Freeport coal in wells in Glade Run basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
W. A. Jack (185)	80	4	W. J. Bowser (193)	55	3
John Miller No. 1 (186)	192	4	Margaret Zimmer (194)	125	3
S. A. McClelland No. 2 (187)	265	4	Samuel Gray (191)	110	4
S. A. McClelland No. 1 (189)	150	....	David R. Bowser No. 3 (204)	80	3
J. V. Easley (188)	272	....			

In a ravine about three-fourths of a mile north of North Buffalo, No. 241, the coal is 3 feet thick, underlain by a good bed of clay and by its limestone, and immediately overlain by 20 feet of sandstone. In the road one-half mile to the east, No. 242, is an old opening in the midst of sandstone. About 1 mile northeast of North Buffalo the coal has been opened at Reed's bank, No. 243. It was not seen here, but is closely overlain by the Mahoning sandstone, which is very coarse. Just across the run east of Reed's bank the coal was found 3 feet thick in a diamond-drill hole (195) on the McKee farm at a depth of 52 feet. In the ravine near the road 2 miles north of North Buffalo, No. 244, the coal is 1 foot 8 inches thick, and is overlain by 40 feet of coarse Mahoning sandstone. A mile east of this point, the coal makes a good showing in the road on the west side of Glade Run, No. 245, and has been opened near by. On the east side of the run, No. 246, is an old opening, and near the bottom of the ravine a little above the latter point, No. 247, the following section was measured :

Upper Freeport coal in ravine east of Glade Run, No. 247 (Pl. VIII, 87).

	Ft.	in.
Dirty coal	1	6
Black shale		10
Shale	1	
Coal	1	
	4	4

On the west side of the run, near the Freeport pike, is an old opening, No. 248, and one-half mile northwest, No. 249, is a working bank on the Sarah Donze farm, at which the coal is 4 feet 6 inches thick and full of very thin partings (Pl. VIII, 88). Along the little run in the southwest corner of East Franklin Township are a number of old openings, Nos. 250 to 252, and 1 mile above this, No. 253, the coal has been opened and worked to a considerable extent near creek level. It goes below the level of the stream at this point. All around the head of this run the coal is closely overlain by 20 feet or more of Mahoning sandstone. East of Glade Run, on the road to Weskit, No. 254, the blossom of the coal shows, and in the ravine eastward on the Coll farm, No. 255, a little coal is reported to have been dug. Sandstone also overlies the coal at this point. On the road crossing Glade Run directly west of Weskit the coal shows on both sides, Nos. 256 and 257. At No. 270 the seam underlies about 30 feet of coarse sandstone, and at No. 271 about 2 feet of black shale were seen, carrying streaks of coal 2 inches in thickness. This accords with the character of a seam as reported in an opening in the next ravine to the west, about one-half mile north of No. 257 and 1½ miles south of Walkchalk. At this opening, No. 258, the following section was obtained:

Upper Freeport coal on Glade Run, 1½ miles south of Walkchalk, No. 258 (Pl. VIII, 89).

	Ft.	in.
Coal and shale alternating in one-half to one-fourth inch layers		3 to 4
Shale		6
Coal	1	6
		5 to 6

The coal also makes a large blossom in the road, No. 259, near the bank at which the the above section was obtained. On the J. B. Drake property, on the east side of Glade Run, is a working bank, No. 260, and two old openings, Nos. 261, 262. In a diamond-drill hole on this farm (258) the Upper Freeport coal is 22 feet deep and 3 feet 4 inches thick. In the W. P. Bowser well (259), on the opposite side of the run and south of Walkchalk, the Upper Freeport coal was found at a depth of 210 feet, and the seam consists of 1 foot 4 inches of coal and slate. The foregoing facts would indicate that the seam is irregular in thickness in this vicinity, and is liable to contain so much shale as to be practically worthless.

On the road running northward from the Drake property, No. 263, the coal makes a good showing underneath heavy sandstone. Along the road for a mile east of Walkchalk the coal shows at several points, Nos. 264 to 265, and is overlain by flaggy sandstone. At No. 264 the showing is large, indicating a thickness of about 4 feet, though the character of the seam could not be determined. About one-half mile north of Walkchalk the coal makes a good showing near the road intersection, No. 266, and is closely overlain by a considerable thickness of Mahoning sandstone. About 2 miles northwest of Walkchalk the coal shows in the road, No. 267, and one-half mile beyond is a bank, No. 268, at which the following section was obtained:

Upper Freeport coal 2 miles northwest of Walkchalk, No. 268 (Pl. VIII, 90).

	Ft.	in.
Coal	3	
Shale	1	4
Coal	1	
	5	4

Near the level of Glade Run, about 1½ miles north of Walkchalk, No. 269, the coal has been opened and is reported 3 feet thick. It probably lies just above creek level for about 1 mile above this point and then begins to rise rapidly toward Cowansville. It shows as an apparently thin bed in the road, No. 270, and again on the top of the hill just south of

the bridge over the railroad track at Cowansville, No. 271. On the hill south of Cowansville post-office, Nos. 272, 273, it also shows as a bed apparently 1 foot thick. About 1 mile east of Cowansville station its blossom was seen in the road, No. 274. About 2 miles northeast of Cowansville the coal makes a good showing near the crest of a ridge, No. 275.

BRUSH CREEK COAL.

The Brush Creek coal shows at a number of points in the Glade Run basin, a few of which are here indicated. It shows in the road as a black shale with streaks of coal about 1½ miles slightly northeast of North Buffalo post-office, No. 276, and about 2 miles farther north along the same road, No. 277. West of Weskit it was noted at two points, Nos. 278, 279. About 1 mile east of Walkchalk, No. 280, it is associated with black shale outcrops and is several feet thick. It shows at other points also, but enough has been said to enable prospectors to identify it, so that they may not be misled into the expenditure of time and money in an effort to develop it, for it is everywhere worthless.

COALS IN ALLEGHENY BASIN WEST OF THE RIVER.

MERCER COAL.

What may be the Mercer seam is exposed in the bed of Limestone Run about one-half mile above its mouth, No. 281, where from 1 to 2 feet of coal was seen. The same coal outcrops in the bank opposite East Brady, No. 282, as a double bed in the midst of shale. It is of no value.

BROOKVILLE COAL.

The Brookville coal makes a good showing in the road on the bluff of the Allegheny opposite Rimer, No. 283, but is not known to the writer elsewhere in this basin.

CLARION COAL.

The Clarion coal is of no value in the Allegheny basin so far as known. It shows at the foot of the bluff just north of Applewold, No. 284, where the following section was obtained:

Clarion coal at Applewold, No. 284 (Pl. VI, 10).

	Ft.	in.
Coal	1	
Shale		10
Coal		8
	2	6

Only a few feet away the lower bench has disappeared and the upper bench only, underlain by 3 feet of clay, was seen. The blossom of the coal was seen at the mouth of Limestone Run, No. 285, and again in the road opposite Rimer, No. 286. Platt[a] reports it 1 foot thick in the ravine of Whiskey Run in Bradys Bend Township.

LOWER KITTANNING COAL.

The Lower Kittanning is the most important seam in the Allegheny basin. It rises from water level a short distance below Kittanning, and crops out at road level at Applewold, where there are several old openings, Nos. 287 to 291. North of Applewold it has been worked in the bluff at Nos. 292, 293, and nearly opposite Ewing are three openings, Nos. 294 to 297, at which the coal is 3 feet thick. In the next ravine, No. 295, one-half mile to the north, the coal is opened at a number of points and is from 2 feet 6 inches to 3 feet thick (Pl. VI, 14). In the second ravine below the mouth of Limestone Run the coal is reported to be 3 feet thick, but the exact point is not known to the writer. This coal is exposed along the Buffalo, Rochester and Pittsburg Railroad on Limestone Run at two points, Nos. 296, 297, within 1 mile above the mouth. At No. 297 the coal is over 2 feet thick. The coal here is at or below railroad level, but the railroad is apparently mapped

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 224.

50 feet too low, for the coal is 1,000 feet above the sea. In the A. B. Wyant well No. 1 (270) the coal is 4 feet thick and 190 feet deep, and in the H. E. Zellifrow well (271) it is recorded at a depth of 175 feet. The coal is of good thickness in the vicinity of Adrian, and has been opened at several points both north and south of that place. To the south are two old openings, Nos. 298, 299. On the north is an old opening, No. 300, a working bank, No. 301, and an old pit, No. 302. At No. 299 the coal is 4 feet thick, at No. 301 it is 3 feet 8 inches thick (Pl. VI, 15), and at No. 302 is 3 to 4 feet thick.

In the George McCracken well (272) about 1 mile northeast of Adrian the Lower Kittanning is reported 4 feet thick at a depth of 170 feet. In the vicinity of Morrows Corner are a number of old openings, Nos. 303 to 305. At the Helm bank, about 1 mile west of Morrows Corner, No. 306, the seam runs from 3 feet to 3 feet 6 inches solid coal (Pl. VI, 16), and three-fourths of a mile northwest of this bank is another old opening, No. 307. About 2 miles west of the last-named point, near one of the head streams of Huling Run in eastern Sugar Creek Township, the coal is reported 4 feet thick in the S. F. Booher well No. 2 (228) at a depth of 110 feet, and in the James Crawford well (227) it is reported at a depth of 100 feet. At No. 308 a good blossom was seen, underlain by clay, that probably indicates the presence of the Lower Kittanning seam.

In a ravine near the boundary between the quadrangles, three-fourths of a mile north of the river, No. 309, the coal is worked and shows the following section:

Lower Kittanning coal three-fourths of a mile north of the river near quadrangle boundary, No. 309 (Pl. VI, 17).

	Ft.	in.
Coal	1	10
Coal with thin partings	1	
Coal	1	8
	4	6

In the Rural Valley quadrangle, one-half mile east of the boundary, is an old opening, No. 310, just above the railroad track. About 1 mile above the railroad bridge at Mosgrove, No. 311, is a bank in which the coal is reported 4 feet 4 inches thick, but in another bank close to this the coal is thinner. The seam in this locality is overlain by heavy sandstone and is probably somewhat irregular in thickness. The coal is opened in a ravine 2 miles farther north, No. 312, and in the next ravine, 1½ miles still farther north, No. 313. West of Mahoning, one-half mile north of the last-named point, are three openings, Nos. 314 to 316. At the first of these the section below is measured:

Lower Kittanning coal west of the river opposite Mahoning, No. 235 (Pl. VI, 18).

	Ft.	in.
Bony coal		6
Coal	4	2
	4	8

In the Myers well (283) near Frenchs Corner the coal is 235 feet deep and 4 feet thick, and in the Abraham Chrisman well (287), northeast of Frenchs Corner, it is 230 feet deep and 4 feet thick.

In the Kittanning quadrangle, about 1 mile north of Frenchs Corner, is the Hooks bank, No. 317, at which the coal is 4 feet 4 inches thick. Near by, No. 318, is another old opening, and one-fourth mile west, No. 319, is another bank at which the coal is 3 feet 8 inches to 3 feet 10 inches thick (Pl. VI, 19). On the river bluff about 1½ miles below Rimer are several openings, Nos. 320 to 322. At No. 322 the coal is reported to run from 2 feet to 3 feet 8 inches in thickness. In the ravine, about three-fourths mile south of Peach Hill, No. 323, the coal has been worked and is reported 4 feet thick, and on the road from Peach Hill down the river bluff opposite Rimer is an old pit, No. 324, at which the coal is also

reported 4 feet thick. Platt[a] states that the coal is 4 feet thick in the vicinity of Sherrett. There is a working bank in the ravine northeast of Sherrett, No. 325, an old working just to the north, No. 326, and on the edge of Sugar Creek Township, 2 miles northwest of Sherrett, No. 327, is another old pit. On the river bluff 2 miles south of Wattersonville is a mine, No. 328. In the ravine of Huling Run, about 1 mile southwest of Wattersonville, No. 329, and in the ravine of Snyders Run, about 1½ miles above its mouth, No. 330, are old openings. South of the river, about 1 mile above Phillipston, is the Keystone mine, at which the Lower Kittanning seam is from 3 feet 6 inches to 4 feet thick. In the ravine of Harts Run the coal shows at Lacys Store, No. 331, and at a number of points below, Nos. 332 to 334, it has been worked to some extent. On Holder Run the coal has been opened one-half mile above its mouth, No. 335. On Sugar Creek, in the vicinity of Kaylor, the Great Lakes Coal Company is opening four mines in this seam—the Snow Hill, Pine Run, Braneman, and Kaylor mines, the latter being a slope. The coal in this locality runs about 4 feet thick, as shown in the natural exposure at creek level just east of Kaylor, No. 336. The coal is reported in the Amos Steele well (245) and the Kepple well (246) south of Kaylor. In the former it is 4 feet thick at a depth of 320 feet, and in the latter 3½ feet thick at a depth of 310 feet. On Pine Run, about 2 miles above the mouth, is an old pit, No. 337, and on Cove Run is another near the northern edge of the quadrangle, No. 338. North of the river, east of East Brady, No. 339, is another old working, while still farther east, No. 340, is a working bank in which the seam is 2 feet 7 inches thick (Pl. VI, 20).

The preceding description shows that the Lower Kittanning coal is under nearly the whole surface of this basin, and is of minable thickness throughout. It is regretted that nothing can be said here of the quality of the coal, but there is no reason to doubt that it is as good as the average Allegheny coal for steaming and fuel purposes.

MIDDLE KITTANNING COAL.

The Middle Kittanning coal seems to be of possible value only in portions of Washington township. In the bluff north of Applewold, Nos. 341 and 342, it is exposed and is 1 foot 3 inches thick (Pl. VII, 43). This probably is fairly representative of the character of the seam throughout most of the area of the quadrangles. North of the mouth of Limestone Run, near the boundary, Nos. 343, 344, its blossom was noted, and along the Buffalo, Rochester and Pittsburg Railroad in the valley of Limestone Run the coal is exposed as a thin seam at two points, Nos. 345, 346. One-half mile south of Adrian, No. 347, is an old opening in this coal, and the same distance southwest of Adrian is another old opening, No. 348, and an exposure in the road, No. 349, where the coal shows about 2 feet thick. About 1 mile southeast of Morrows Corner, Nos. 450, 451, are two old pits apparently in this coal, but there is a possibility of mistake in the identification of the coal seams in this locality and that the coal at the points given above is Lower instead of Middle Kittanning.

In the William Johns well (285), north of Frenchs Corner, what appears to be the Middle Kittanning seam is reported 4 feet thick at a depth of 166 feet. Near the head of Limestone Run, No. 452, coal fragments were noted, and one-half mile west is an old opening across the ravine north of the road, No. 453. This seam is probably to be regarded as Middle Kittanning. North of Morrows Corner the blossom of this coal was noted at several points, Nos. 354 to 356. In the vicinity of Sherrett the coal has been opened at a number of places. From one-half mile to 1 mile south of that place are three old openings, Nos. 357 to 359. At No. 359 the coal is reported 3 to 4 feet thick. Nearer Sherrett it makes a good showing in the road, No. 360. One-half mile southeast of that place, No. 361, is an old opening, and three-fourths of a mile southwest, No. 362, are two old openings. About 1 mile still farther west in eastern Sugar Creek Township, No. 363, fragments of coal prob-

[a] Second Geol. Survey Pennsylvania Rept. H5, p. 228.

ably indicate the presence of this seam. Along the road on the river bluff below Peach Hill, No. 364, the following section of what appears to be this coal was obtained:

Middle Kittanning coal near Peach Hill, No. 364 (Pl. VII, 44).

	Ft.	in.
Coal	3 6 to 4	
Slate	1	6
Coal	1	6
	6 6 to 7	

Still farther north along this ridge, 1½ miles south of Wattersonville, No. 365, what is regarded as this seam is mined and shows the following section:

Middle Kittanning coal near Wattersonville, No. 365 (Pl. VII, 45).

	Ft.	in.
Coal	3	3
Hard block coal	1	6
	4	9

On Harts Run, just east of Lacys Store, No. 366, a seam 5 feet 2 inches thick is exposed and is apparently Middle Kittanning. In the Amos Steele well (245), south of Kaylor, what appears to be this coal is recorded 5 feet thick at a depth of 280 feet.

UPPER KITTANNING COAL.

The Upper Kittanning coal is a mere thread at the base of the Freeport sandstone on the road up the bluff at Weskit, No. 367, but in the ravine just to the west of Weskit, No. 368, it makes a good showing. In the road up the ravine west of the river opposite Ewing, No. 369, the coal is reported 1 foot 6 inches thick, and near the head of the ravine west of the river three-fourths mile above Ewing, No. 370, what is probably this coal makes a large showing. One mile southeast of Adrian are two old pits in this coal, Nos. 371 and 372. One-half mile north of Adrian the coal shows in the road, No. 373, and one mile northeast of the last-named point, No. 374, it is exposed to a thickness of 2 feet. One-half mile north of Frenchs Corner the Upper Kittanning coal shows in the run, No. 375, and near by, No. 376, is an old pit, where it is reported 3 to 4 feet thick. About 2 miles northeast of Frenchs Corner, in the Rural Valley quadrangle, what is probably this coal makes a small showing in the road, No. 377. In the Miller Bowser well (284) and in the Myers well (283) this coal is reported. In the former it is 5 feet thick at a depth of 240 feet, and in the latter 3 feet at a depth of 140 feet.

Near the hilltop, about 1½ miles northeast of Morrows Corner, No. 370, the Upper Kittanning coal is now worked and is reported 4 to 5 feet thick. Near the road on the river bluff below Peach Hill, No. 379, the coal has been opened and is reported 4 feet thick, but irregular and soon thinning to nothing. About one-half mile southwest of Peach Hill No. 380, are two old openings, and three-fourths of a mile farther west are others, Nos. 381, 382. At No. 381 the following section is reported:

Upper Kittanning coal south of Sherrett, No. 381 (Pl. VII, 51).

	Feet.
Coal	4 to 6
Shale	1
Coal	2
	7 to 9

At No. 382 the coal is reported 7 feet thick with 1 foot of shale in the middle. In this locality Platt[a] reports the following section:

Upper Kittanning coal south of Sherrett (Pl. VII, 52).

	Ft.	in.
Coal	3	2
Shale	1	3
Coal		6
	4	11

Along the road east of Sherrett are two old openings, Nos. 383, 384. About three-fourths of a mile west of Sherrett, No. 385, and on Snyders Run, about 3 miles above its mouth, No. 386, are other old openings in this same coal. The Ganner mine at Somerville, No. 387, is noted in the region for the great thickness attained by the Upper Kittanning seam. Platt[b] (H5, p. 222) published the following section measured at this mine:

Upper Kittanning coal, Ganner mine, Somerville, No. 387 (Pl. VII, 53).

	Feet.
Bituminous coal	2 to 5
Cannel slate	0 to 7
	2 to 12

Platt[b] says of the seam here and in the region generally:

The Kittanning Upper coal seam occurs almost directly underneath the Freeport sandstone. Ten inches thick along the river front, it receives a rider of cannel slate in the ravine of Holder Run, becoming upward of 12 feet thick. The bed generally is obscure. The cannel slate exists only in irregular depressions or concavities, similar to those already described in connection with the same Kittanning Upper seam at Bostonia on the Redbank and at Mrs. Thompson's on the Little Mudlick. Out of the depressions the bed is sometimes scarcely more than a streak in the rocks. A good exhibition of its cannel-slate feature may be had at the Ganner mine in the ravine of Holder Run, at which place the bed is 2 feet thick at the outcrop, increasing within a short distance to 5 feet, all bituminous coal of a fairly good quality. The floor of the seam then rapidly descends at an angle of 10° to a depth of 7 feet, the roof meanwhile remaining horizontal. The interval between is gradually occupied by mass of impure cannel slate of a dull luster and having a conchoidal fracture. The bed being below the water level of the run, difficulty is encountered in draining the mine, which fact has put a stop to the developments in that direction, leaving the limits of the cannel-slate deposit a matter of conjecture. The "cannel," however, is of no value, being much too impure even for domestic purposes. The over- and underlying strata are so well exposed on the Ganner property that the geological horizon of the cannel-slate deposit can there be satisfactorily determined.

It is evident that the thickness reached in the Ganner mine is not persistent over any great area, since it does not show in outcrop in the bluff one-fourth mile below the mine, where the rocks are well exposed. In the Kepple well (246), south of Kaylor, this coal is reported 2 feet thick at a depth of 235 feet. Just north of Kaylor is a working bank, No. 388, and about 1 mile northeast, No. 389, is an abandoned working.

LOWER FREEPORT COAL.

The Lower Freeport coal is not much known south of Weskit in this basin. Along the road one-half mile south of Weskit, No. 390, its blossom was observed, as also in the road one-half mile to the west of that place, No. 391. At Weskit, No. 392, and a little farther north, No. 393, its blossom was noted, and at the latter place it makes a good showing. About 1½ miles northwest of Weskit, No. 394, is an old opening, and in the road one-fourth mile east of the latter point, No. 395, the coal makes a good showing and is probably 3 feet or more thick. No further traces of this coal were seen along the river north of this point. On the hill south of Adrian its blossom was noted in the road, No. 396. About 1 mile east of Adrian, No. 397, and about 1 mile west of Frenchs Corner, No. 398, it also makes a good showing. In the William Johns well (285) north of Frenchs Corner what appears to be this coal 3 feet thick is noted at the depth of 75 feet, and in the Abraham Chrisman well (287) to the northeast it is also reported 3 feet thick at the depth of 60

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 229. [b] Op. cit., p. 222.

feet. At Peach Hill, No. 399, the coal makes a good showing and a thickness of about 3 feet is indicated. About 2 miles west of Sherrett it shows near the crest of a ridge crossed by the highway, No. 400, and also about one-half mile to the north, No. 401. At No. 400 it is apparently 1 to 2 feet thick. The blossom of what seems to be this coal was seen about 1 mile southeast of Lacys Store, No. 402. On the whole, the Lower Freeport coal does not promise much in this area.

UPPER FREEPORT COAL.

The Upper Freeport seam is of good thickness over most of the areas underlain by it in this basin. In the river bluff opposite Ford City the coal appears to be pinched out, at least locally, as shown by the fact that at one point on its outcrop, No. 403, it is only about 6 inches thick. Near the road 2 miles to the north, across the river from Manorville, No. 404, it is thicker and overlain by the Mahoning sandstone. Below is a section measured at this point:

Upper Freeport coal opposite Manorville, No. 404 (Pl. VIII, 91).

	Ft.	in.
Shaly coal	1	3
Coal		6
Clay		2
Slaty coal		6
Coal	2	6
	4	11

One-half mile west of Weskit the blossom of the coal was seen in the road, No. 405, and one-half mile northwest of this point it was recorded in the Blair well (257) 90 feet below the surface. Just north of Weskit it makes a blossom in the road, No. 406, and about 1 mile farther north it shows at points, Nos. 407, 408. About 2 miles northwest of Ewing are two old pits, Nos. 409, 410. Along the road south of Adrian the coal is known at several points. Near the head of the first ravine west of Limestone Run, No. 411, is an old bank, and in the next ravine to the north, No. 412, is another. The blossom of the coal was noted on the north side of this ravine, No. 413, and over the ridge beyond, three-fourths of a mile south of Adrian, is another old opening, No. 414. About 1 mile southwest of Adrian, No. 415, is an old bank, and to the north the blossom was observed at three points, Nos. 416, 417, 418. One mile north of the mouth of Limestone Run, No. 419, the coal makes a good showing in the road, and in the ravine one-half mile northeast, No. 420, is an old pit. Just across the boundary in the Rural Valley quadrangle, about three-fourths of a mile west of West Mosgrove, No. 421, is a bank at which the following section was measured:

Upper Freeport coal west of West Mosgrove, No. 421 (Pl. VIII, 92).

	Ft.	in.
Coal, three thin partings		9
Coal	3	
	3	9

On the hill about one-third of a mile northwest of the railroad bridge at Mosgrove is an old opening, No. 422. One-half mile south of Frenchs Corner, No. 423, is another, and on the ridge nearly opposite Templeton, No. 424, is another, at which the coal is reported about 2 feet thick and poor. It is reported generally poor to the northeast of Frenchs Corner. In the James Toy well (273), southwest of Frenchs Corner, the coal was penetrated at the depth of 110 feet and is 4 feet thick. On a knob one-half mile south of Peach Hill, No. 425, is an opening at which the seam is 5 feet thick, with many thin partings of shale (Pl. VIII, 93).

At Peach Hill the coal makes a good showing on both sides of the ridge, No. 426. About one-half mile northeast of Sherrett the coal is exposed near the top of a knob, No. 427. Still farther north along the ridge west of the river is an old opening, No. 428, and a good

blossom, No. 429. On a knob crossed by the Washington-Sugar Creek boundary, 2½ miles north of Cowansville, is a small area of the seam which has been opened at No. 430. On the Crawford farm, 1 mile west of Sherrett, Platt[a] obtained the following section:

Upper Freeport coal on Crawford farm 1 mile west of Sherrett (Pl. VIII, 94).

	Ft.	in.
Coal	2	1
Shale		2
Coal	1	6
	3	9

The exact location of this bank can not be determined.

About 1½ miles west of Sherrett, No. 431, the blossom of the coal was seen, and on the knob about 2 miles west of Sherrett the coal was noted at four points, Nos. 432 to 435. At No. 435 is an old pit at which the coal is reported 4 feet 2 inches thick. About 1 mile south of the mouth of Snyders Run, No. 436, a good blossom of the Upper Freeport coal was seen in the road. Within 1 mile northeast of Browns Crossroads is an old pit, No. 437, at which the coal is reported 4 feet thick. Just south of the ridge from the last-named point, No. 438, a blossom was seen in the road, and there is another old opening, No. 439, one-half mile to the west. A little over a mile to the northeast of Adams the coal was observed at three points, Nos. 440 to 442. At the first and last of these points the blossom was noted and at the other is an old pit. About 1 mile southeast of Lacys Store, No. 443, the coal makes a large blossom, and about one-half mile west of this point, No. 444, about 1 foot 6 inches of coal was observed. Near the road one-half mile southeast of Lacys Store, No. 445, is an old pit, and 1 mile to the east near the Keystone mine the blossom of the Upper Freeport coal was observed in the road, No. 446. On the knob at the apex of the river bend at East Brady, No. 447, the coal has been worked in connection with its underlying iron ore. About a mile to the west, on the hill west of Holder Run, No. 448, is an old opening. The following section published by Platt[b] was obtained somewhere in this general region, but the exact location is unknown:

Upper Freeport coal at Bradys Bend (Pl. VIII, 95).

	Ft.	in.
Coal	1	
Fire clay and roof slate	1 to 1	 6
Coal	2	4
Slate		3
Coal	1	10
Shale	2	6
Coal		4
	9 to 9	3 9

Just west of Somerville are two old pits, Nos. 449, 450. To the south and southeast of Kaylor are the Barnhart and Reese mines in the Upper Freeport coal. In the Amos Steele well (245) and the Kepple well (246) in this vicinity, the coal is recorded at a depth of 100 feet, being in the former 5 feet and in the latter 3 feet thick. To the west the blossom of the coal was seen about 1 mile southwest of Kaylor, No. 451, and one-half mile east of Kepples Corners, No. 452, is an old opening. Near the northern margin of this quadrangle, northwest of Kaylor, is an old opening, No. 453. About 1 mile east of Karns are three old openings, Nos. 454 to 456. About 1 mile south of Karns is the Enterprise mine, in which the coal is 4 feet to 4 feet 6 inches thick (Pl. VIII, 96). Just southwest of this mine, No. 457, is an old opening at which the coal is said to be 3 feet thick. About 1½ miles southwest of Karns are two old pits, Nos. 458, 459, and near by, No. 460, the coal makes a good showing in the road. About one-half mile southwest of Karns are two old mines, No. 461. To the northwest of Karns are several old openings, Nos. 462 to 463, and one working bank, No. 464.

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 228. [b] Op. cit., p. 219.

BRUSH CREEK COAL.

The Brush Creek coal is exposed at the road intersection one-half mile south of Frenchs Corner, No. 465, and appears to be over 1 foot thick. It also makes a small blossom in the road one-half mile north of Frenchs Corner, No. 466, and about 1 mile northeast of that place, No. 467.

COALS IN ALLEGHENY BASIN EAST OF THE RIVER.

None of the coals below the Lower Kittanning coal are of any value in this territory, but a few points are indicated where they were observed.

POCONO COALS.

Two or three thin seams of impure coal outcrop in the Pocono formation in the river bluff above Mahoning, No. 468. None of them exceeds 1 foot in thickness. These coals also show along the incline of the Riverview mine north of Cosmos at 80 to 100 feet above the Allegheny Valley Railroad.

MERCER COALS.

What may be Mercer coal is reported in the Thomas Smith well near Ford City (300) and in the George Aye well (302). In the former it is recorded 3 feet thick at the depth of 380 feet, and in the latter 7 feet thick at 470 feet. The thin streaks and pockets of coal occurring at the base of a heavy sandstone along the road on the bluff between Templeton and Mahoning, No. 469, are referred to this group, and so also are two seams 8 and 12 inches thick at 227 and 235 feet above the railroad in the section along the incline at the Riverview mine, and a thin coal or coaly shale on the bench southeast of Redbank station, No. 470.

BROOKVILLE COAL.

What is probably the Brookville coal crops out in the river bluff between Templeton and Mahoning, about 200 feet above the railroad track, No. 471. It is apparently 2 to 3 feet thick.

CLARION COAL.

The Clarion coal is revealed as a thin seam 6 inches to 1 foot thick in connection with the clay workings at Wickboro, Ewing, and Cowanshannock station, and at Templeton. It is of no value.

LOWER KITTANNING COAL.

The Lower Kittanning coal is apparently over 200 feet below the surface and 3 to 5 feet thick in the southeast corner of the Kittanning quadrangle, as shown in the following records of deep wells in the vicinity of Ford City:

Lower Kittanning coal in wells near Ford City.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
Logan well (291)	360	3
John Hellman well (293)	225	5
Montgomery No. 2 well (299)	294	4
Jacob Hobaugh No. 1 (305)	115	5

The coal rises from water level just below Kittanning and is revealed in the quarries of the Kittanning Clay Manufacturing Company about 75 feet above the river, at which point

it is 3 feet 6 inches thick (Pl. VI, 21). At the old Reynolds quarries, the location of which is unknown to the writer, Platt [a] obtained the section given below:

Lower Kittanning coal, Reynolds quarries, Kittanning (Pl. VI, 22).

	Ft.	in.
Coal		10
Bony coal		2
Coal	1	4
Parting (chiefly pyrite)		1
Coal	1	4
Bony coal		4
	4	1

Platt describes the coal as of indifferent quality, as indeed the presence of pyrite (the source of sulphur) and bone would indicate.

At Kittanning is the McNees & Painter mine of the Kittanning Clay Manufacturing Company, at which the coal is largely mined for use at the present time. Analysis No. 4 (p. 98) is of a sample from this mine. On the hill east of Wickboro, No. 472, the coal is 3 feet 6 inches thick at a working bank; 1 mile farther north are old mines, No. 473, at which the coal is 4 feet 4 inches thick. Just south of the mouth of the Cowanshannock, No. 474, the seam is now mined and is 4 feet thick (Pl. VI, 23), and across the creek to the north is an old opening, No. 475, and a mine, No. 476. See analysis No. 5 (p. 98) for the composition of the coal at this bank.

On Hays Run, about 1 mile above the mouth, No. 477, the coal is exposed at water level and is overlain by a heavy sandstone. It shows the following section:

Lower Kittanning coal on Hays Run, No. 477 (Pl. VI, 24).

	Feet.
Sandstone with thin layers and pockets of coal	1
Coal	2 to 3
	3 to 4

Near the river, about 2 miles above Mosgrove, No. 478, is an old opening beneath a heavy sandstone, at which the coal is 3 feet 6 inches thick (Pl. VI, 25). Two miles below Templeton, No. 479, there is an abandoned mine at which the coal is 4 feet thick, but reported to be largely a cannel shale. In the ravine to the east of Templeton, No. 480, the following section was measured by the writer at a working bank:

Lower Kittanning coal near Templeton, No. 480 (Pl. VI, 26).

	Ft.	in.
Coal		2
Parting, very thin.		
Coal		2
Parting, very thin.		
Coal		5
Parting.		
Coal		9
Parting (shale)		½ to 1
Coal		6
Parting.		
Coal		2
Parting.		
Coal		2
	2 to 2	4½ 5

Platt [b] reports this coal 1 foot 6 inches thick in Templeton ravine, which is probably the ravine in which the above measurement was obtained. In the region overlooking the river

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 250. [b] Op. cit., p. 234.

along the bend above Mahoning the coal was observed at the points described below: North of Mahoning is the opening of an old mine, No. 481; three-fourths of a mile farther north is a bank, No. 482; at Nos. 483 and 484 the coal outcrops in the road; and at No. 485 are two old banks. North and east of Rimer the coal has been extensively worked at country banks. The positions of the old openings are indicated by Nos. 486 to 494. At No. 486 is a well-timbered old opening that would indicate a mine of some proportions. About 1½ miles north of Cosmos there is a bank, No. 495, and near by, No. 496, the coal makes a good showing in the road. At the Riverview mine, 1½ miles north of Cosmos, the coal is 3 feet thick. In the ravine to the east, No. 497, is another opening, and 1 mile farther east, No. 498, there is a working bank. North of the Riverview mine are a number of openings, Nos. 499 to 501, and a little north of the last is a working bank, No. 502. The coal runs from 3 to 4 feet in thickness in this region. On the point of the spur at Redbank, No. 503, is an old mine, and in the ravine to the north, No. 504, is an old pit. In the Monarch mine on the river bluff 1½ miles above Redbank the seam is 3 feet to 3 feet 6 inches thick (Pl. VI, 27).

One and one-half miles west of the Monarch mine is an old opening, No. 505. One mile west of Phillipston, No. 506, the following section was measured in a working bank:

Lower Kittanning coal 1 mile west of Phillipston, No. 506 (Pl. VI, 28).

	Feet.
Bony coal	2
Coal	3
	5

From East Brady northward along the river bluff are a number of old workings, Nos. 507 to 512. It is shown by the foregoing description that the Lower Kittanning coal is of workable and generally of good thickness throughout all this region.

MIDDLE KITTANNING COAL.

The Middle Kittanning coal was scarcely recognized in this area, and is probably of little or no value. Its blossom shows in the road one-half mile west of Phillipston, No. 513.

UPPER KITTANNING COAL.

The UpperKittanning coal is practically unknown, and probably is of little value, in this territory. In the Thomas Smith well (300), before mentioned, what seems to be this coal is reported 4 feet thick at a depth of 246 feet. It shows in the bluff of the river just north of Garrett Run, No. 514, as a mere thread in sandstone, and along the trolley road a little farther north, No. 515, as a seam 4 to 6 inches thick. In the ravine at the southern end of Kittanning, No. 516, it also makes a small showing, as it does in the road above the cemetery at the north end of town, No. 517. On a knob north of Mahoning station the coal makes a large showing, No. 518, and is apparently 2 to 3 feet thick. Near Tidal, in the northwest corner of the Rural Valley quadrangle, No. 519, it is a bony coal 2 feet 6 inches thick (Pl. VII, 54).

LOWER FREEPORT COAL.

Very little is known of the Lower Freeport coal in the region, and it is probably of little value. What is regarded as this seam is noted in wells near Ford City, as follows:

Lower Freeport coal in wells near Ford City.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
Logan (291)	244	4
Charles Heilman (294)	125	5
George Aye (302)	120	6

It is exposed 1 foot thick along the trolley road between Garrett Run and Kittanning, No. 520. In the ravine already mentioned at the southern end of Kittanning, No. 521, it is represented by a bed of black, fossiliferous shale several feet thick. In the road east of Kittanning, No. 522, it makes a good showing, and in the ravine a short distance to the east, No. 523, are old openings that appear to be in this coal. In the road above the cemetery, No. 524, it shows well, and in this vicinity Platt[a] obtained the following section:

Lower Freeport coal near pike northeast of Kittanning, No. 524 (Pl. VII, 66).

	Ft.	in.
Coal	3	
Shale		3
Coal		6
Shale	6	
Coal	3	8
	13	5

The upper bench of coal is somewhat slaty, but the lower is good coal. According to Platt[a] the seam was opened at another place near by, but had thinned down to a few inches. These facts indicate that the seam is exceedingly variable in this locality and probably of little value.

Near the head of Hays Run, No. 525, this coal is exposed in the road to the thickness of 1 foot 6 inches, and it may be thicker. High up on the bluff of the Allegheny, about 3 miles above Mosgrove, No. 526, the coal is exposed about 20 feet below the Upper Freeport coal, and is 2 feet 6 inches thick (Pl. VII, 67). This coal may probably be disregarded as an economic factor in the region.

UPPER FREEPORT COAL.

The Upper Freeport is a valuable coal throughout the eastern part of the Allegheny basin. It is under nearly all the area in the southern portion, but its extent in the northern part is small, being confined to a few high hilltops. At the southern end of Ford City it outcrops in the bluff, No. 527, and is mined in a ravine 2 miles east of that place, No. 528, where it is 3 feet 7 inches thick (Pl. VIII, 97). It is exposed and of good thickness along the road on the face of the bluff north of Ford City, No. 529, and in the ravine one-half mile to the east, No. 530, is an old pit. In the Crytzer well, just across the boundary in the Rural Valley quadrangle, it is reported 6 feet thick at a depth of 175 feet. In the vicinity of Manorville Platt[b] reports this coal 3 feet 6 inches thick on the average. Along Garrett Run and its branch, called Rupp Run, this coal has been opened at a number of points and is of good thickness throughout. About one-half mile east of Manorville is an old opening, No. 531, and the showing in the road near by indicates a thickness of 3 feet. Three-quarters of a mile northeast is another opening, No. 532, at which the coal is said to be about 4 feet thick. At Nos. 533 to 535 are old openings. The coal at No. 534 is near water level and immediately overlain by the Mahoning sandstone. In the next ravine one-half mile to the east, No. 536, is the Miller bank, at which the section below was measured:

Upper Freeport coal at the Miller bank, Garrett Run, No. 536 (Pl. VIII, 98).

		Ft.	in.
Bone and clay			2
	to		6
Coal		1	6
	to	1	10
Clay			½
Coal		2	
		3	8½
	to	4	4½

[a] Second Geol. Survey Pennsylvania, Rept. H5. p. 253.

[b] Op. cit., p. 257.

A short distance south of the Miller bank, at the junction of Rupp and Garrett runs, No. 537, is an opening at which the coal is 3 feet 6 inches thick. One-half mile up Rupp Run is the Hobaugh bank, No. 538, at which the following section was measured:

Upper Freeport coal at Hobaugh bank, Rupp Run, No. 538 (Pl. VIII, 99).

	Ft.	in.
Coal, with thin clay partings		6
Coal		9
Parting		½
Coal	3	
Parting		½
Coal	2	2
	6	6

The coal here shows considerable pyrite in irregular streaks. One-half mile above the Hobaugh bank the coal is exposed in a ravine, No. 539, and is over 3 feet thick. Still higher up the run, No. 540, the coal has been stripped from the stream bed and near by is an old bank, No. 541. Near the head of Rupp Run the coal was noted in the G. S. Rohrer well (319) at a depth of 80 feet and reported 4 feet thick. Near the head of Garrett Run on the south, at No. 542, the coal was reported. Just below, No. 543, its limestone is quarried, and in the Margaret Wallace well (318) the coal is reported 80 feet deep and 4 feet thick. The coal is worked somewhat extensively at a number of banks along the north side of Garrett Run, Nos. 544 to 548. At the Chambers Heilman bank near the junction of the runs, No. 549, the section of the coal was given by Mr. Heilman as follows:

Upper Freeport coal at Chambers Heilman bank, Garrett Run, No. 549 (Pl. VIII, 100).

	Ft.	in.
Coal	3	4
Bone		2
Coal		6
	4	

Along the south branch of Garrett Run are old openings, Nos. 550 to 554. At the Jacob Stitt bank, No. 555, considerable coal is taken out. The section at this point is given below:

Upper Freeport coal at Jacob Stitt bank, Garrett Run, No. 555 (Pl. VIII, 101).

	Ft.	in.
Bone		9
Coal	3	2
	3	11

Just east of the Stitt bank are old pits, No. 556. Beyond this point the coal begins to rise more rapidly toward the axis of the Greendale anticline to the east, and can be traced along the road for some distance, but is lost sight of near point No. 557. The Upper Freeport seam in this region can probably be depended upon to yield about 3 feet 6 inches of good coal, and the topographic and structural conditions are very favorable for mining it.

In a ravine one-half mile northeast of Garrett Run, No. 558, and above the road between Garrett Run and Kittanning the coal has been opened, No. 559. In the ravine followed by the Indiana pike over the hill southeast of Kittanning, No. 560, the coal was extensively mined at one time, but the mine is now abandoned, probably owing to the fact that the mine was driven down the dip, and the difficulty of draining by drifts at lower levels was found too great. Going northward the coal shows below several feet of flaggy sandstone in the ravine at the south end of Kittanning, No. 561; its blossom shows in the road east of town, No. 562, and there is an old opening in it on the road to the northeast, No. 563.

According to Platt [a] this coal runs from 3 feet 6 inches to 4 feet in thickness in this locality, in some places with thin shale partings.

North of the mouth of Cowanshannock Creek are old openings, No. 564, and a working bank, No. 565. To the east, along Hays Run, is an old opening, No. 566, and a working bank on the farm of Caspar Reed, No. 567, at which the coal is 4 feet thick (Pl. VIII, 102). The coal is here quite closely overlain by Mahoning sandstone. Just across the run from Reed's bank is an old opening, and near by the coal is exposed in the road, No. 568. One-half mile farther up the run is a bank on the Banks property, No. 569. Near the mouth of Hays Run on the north is the Mosgrove mine, of which an opening is shown, No. 570. The coal at this mine varies in thickness from 3 feet to 3 feet 10 inches, with an average of about 3 feet 6 inches. It is more or less affected by rolls or horsebacks of sandstone, which cut out the coal locally and add considerably to the expense of mining. Analysis No. 26 (p. 98) is of a sample from this mine. About one-half mile to the north of the Mosgrove mine is an old opening, No 571. One mile above the mouth of Pine Creek the blossom of the coal shows in the road, No. 572, and still farther north in the river bluff, No. 573, it is exposed beneath the Mahoning sandstone, which is 40 to 50 feet feet thick, while the coal is 3 to 4 feet thick. Still farther north, No. 574, the coal is mined at a bank on the river bluff 1½ miles south of Templeton, the coal being 2 feet 2 inches to 2 feet 4 inches thick (Pl. VIII, 103). It is overlain by 10 feet of rusty shale, and this in turn by 10 feet of flaggy sandstone. In the ravine about 1 mile southeast of Templeton, No. 575, the following section was measured at a bank:

Upper Freeport coal east of Templeton, No. 575 (Pl. VIII, 104).

	Ft.	in.
Bone and coal		2
Coal with three or four partings	2	11
	3	1

The coal is here overlain by rusty shale and this in turn by flaggy sandstone. On the hill between Templeton and Dee, No. 576, is another bank, at which the coal is 2 feet 8½ inches thick, with an inch of bone at top. North of this locality the coal occurs only on a few knobs in Madison Township in both Armstrong and Clarion counties. South of Redbank Creek it has been opened at two points, Nos. 577 and 578, but nothing was learned of its character or thickness. Just to the north of these openings its blossom shows in the road at two points, Nos. 579 and 580, and at the latter point a thickness of at least 2 feet is indicated. Along the ridge east of East Brady the coal shows in the road at several points, Nos. 581 to 583. Just to the south of the latter point are old banks, No. 584, with indications of extensive mining, and one-half mile to the north is another old mine, No. 585.

BRUSH CREEK COAL.

The Brush Creek coal is present in the southern part of this basin, and a few points are indicated at which it was observed: Southeast of Ford City, No. 586; about 1½ miles to the east, No. 587, and on the Indiana pike on the hillside, where it descends into the valley of Rupp Run, No. 580. The coal is of no value here. South of the head of Hays Run this coal is exposed in the road, No. 589, appearing to be about 2 feet thick, and about three-fourths of a mile to the east the same seam has been opened and worked on the A. C. Ellenberger farm, No. 590. Mr. Ellenberger reports the coal 2 feet 6 inches thick and of excellent quality. This is the only place in the quadrangles where the coal is known to be of minable thickness.

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[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 256.

COALS IN THE COWANSHANNOCK BASIN.

So far as known the lower coals have little or no value in this basin. The few facts known, however, may be of sufficient interest to warrant giving them.

BROOKVILLE COAL.

The Brookville seam outcrops near creek level just below the point where the creek is crossed by the axis of the Greendale anticline, No. 591, where it is 6 inches thick and associated with black shale. What is probably this seam is noted in the D. A. McAfoose well (465), 2 miles north of Yatesboro, at the depth of 455 feet. The coal is reported 5 feet thick, but it is probable that this thickness is mostly black shale.

CLARION COAL.

In a ravine one-half mile east of Stone House, No. 592, the Clarion coal outcrops and is 6 inches thick. Its clay shows by the roadside near the axis of the anticline, No. 593, and the coal is again exposed above Greendale at creek level, No. 594, where it is a few inches thick

LOWER KITTANNING COAL.

The outcrop of the Lower Kittanning coal in this basin is of small extent. Over most of the area it is deep beneath the surface, and knowledge of it has been gained entirely from deep-well records, in a few of which it has been identified with a greater or less degree of certainty. The coal outcrops from the mouth of the creek to the boundary between the quadrangles, at which point it dips below water level toward the axis of the Fairmount syncline, where it is 100 feet below the surface. It rises eastward from this axis and emerges from cover one-half mile east of the boundary between Rayburn and Valley townships; thence it outcrops along the valley to a point 1 mile east of Greendale, where it descends finally below the surface. Along its outcrop west of the Fairmount syncline the coal is good, but east of the syncline the indications are mostly unfavorable.

Near the mouth of the creek the coal has been opened at several points on the south side, Nos. 595 to 597. At No. 597 it is 2 feet 6 inches thick. On the north side of the creek the coal makes a good showing at the road intersection one-half mile above the mouth, No. 598. A little farther up is an opening, No. 599, and at the junction of a ravine from the east, No 600, is an old mine at which the coal was once extensively worked. What is regarded as this coal is exposed 1 foot thick in a cut of the projected trolley road between Kittanning and Rural Valley, about one-half mile east of the Rayburn-Valley boundary, No. 601, and it shows in the bank along the road east of the cut, No. 602. In a ravine one-half mile east of Stone House No. 603, its blossom associated with clay was observed and a considerable thickness was indicated, and in the next ravine to the east is an old opening, No. 604. Its presence is indicated by fragments in the road near the anticlinal axis, No. 605, and about 1¼ miles farther east, No. 606, is an old bank at which considerable coal has evidently been taken out. This may be the Rhea bank, at which Platt[a] reports the seam to vary from 2 feet 6 inches to 4 feet in thickness. Analysis No. 7 of the table (p. 98) is of a sample from this bank.

This coal is noted in the following wells in the basin:

Lower Kittanning coal in wells in Cowanshannock basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Peter Heilman No. 2 (313)	225	4	Burns (418)	388	5
George L. Blose (315)	220	....	Reisinger (450)	105	6
McElroy (316)	375	3	Gourley heirs (453)	320	3
Collum No. 1 (321)	295	5	Brown (473)	330	3

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 96.

MIDDLE KITTANNING COAL.

The blossom of the Middle Kittanning coal appears in the road 1½ miles northeast of Kittanning, No. 607, and was seen in the bank at the road intersection one-half mile east of Rayburn-Valley boundary, No. 608. In the ravine before mentioned one-half mile east of Stone House, No. 609, it is exposed and is 1 foot 6 inches thick. A coal that appears to be in the position of the Middle Kittanning is noted in the John Boyer well (416) in Plum Creek Township at the depth of 515 feet.

UPPER KITTANNING COAL.

The blossom of this coal was seen in roads leading down to Cowanshannock Creek, 1½ miles northeast of Kittanning, Nos. 610 and 611. It was noted at a few points above McNees on Mill Run, Nos. 612 to 614. At No. 612 is an old pit that seems to be at the level of this coal. At No. 613 is an opening at which the coal is 1 foot 6 inches thick, and at No. 614 the coal is exposed in the road and is about 2 feet thick. Along Cowanshannock Creek it is reported about 1 foot thick at J. M. Schreckengost's house, No. 615, and shows by the roadside a few rods beyond. It is exposed in the ravine one-half mile east of Stone House, No. 616, where it is 1 foot 6 inches thick. South of Cowanshannock Creek, east of Greendale, No. 618, it shows in the road and is over 1 foot thick. One mile west of Yatesboro, at road level, No. 614, the coal is worked by Mr. Benjamin Schreckengost, and is reported 4 feet thick. (See analysis No. 16, p. 98, for the composition of the coal at this point.) Mr. Schreckengost regarded his coal as the Lower Freeport, so did Platt[a], but its relations to the Vanport limestone, which is recorded in the Kennerdell and Reisinger wells (449 and 450) near by at 120 and 111 feet, respectively, show that the seam in question more nearly accords in position with the Upper Kittanning.

The Upper Kittanning coal is recorded in a number of wells in this basin as follows:

Upper Kittanning coal in wells in Cowanshannock basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Peter Heilman No. 2 (313)	110	3	Wampler (441)	268	5
Thomas N. Bowser No. 1 (352)	218	4	J. A. Bowser (443)	228	4
Madison Wagoner (420)	400	....	Gourley heirs (453)	221	7
Jacob Espey (427)	215	....	William Schreckengost (461)	308	4
Smith (433)	90	4	Brown (473)	210	8

The consistency of these well records, in connection with the observed thickness of the seam at the Schreckengost bank, indicates a possible workable area of Upper Kittanning coal of large extent. Of course the drill records can not be depended on for precise measurements, and reveal nothing as to the character of the seam—whether it is all coal or partly shale—nor as to the quality of the coal. They yield sufficient information, however, to warrant further investigation.

LOWER FREEPORT COAL.

The Lower Freeport seam has a wide extent of outcrop in this basin, and all observations point to the fact that it is probably workable along the whole outcrop, but very little can be said of it in the southeast corner of the Rural Valley quadrangle, where it is under deep cover. In the western part of the basin it runs 50 to 60 feet below the Upper Freeport seam, but in the vicinity of Yatesboro the interval decreases to 30 feet.

West of Cowanshannock Creek, northeast of Kittanning, the coal yields a good blossom in the roads, Nos. 620 and 621. Farther up the creek, in the Rural Valley quadrangle, Nos. 622 to 625, indications of the coal were noted. At Nos. 622 and 624 it shows as a worthless

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 93.

shaly bed a foot or two in thickness. Going southeast along Mill Run the coal increases in thickness and improves in quality. On the road east of McNees, No. 626, it makes a good showing and has been mined. One-half mile above McNees is an old pit, No. 627, and in a ravine about three-fourths mile southeast of the last-named point the coal is exposed in the stream bed, No. 628, apparently 2 to 3 feet thick. North of Mill Run, 1½ miles east of McNees, the coal has been opened in a ravine, No. 629. One mile farther up the run the coal is opened at the Ruffner bank, No. 630, and is 2 feet 6 inches thick (Pl. VII, 68). At a bank, No. 631, up the ravine north of Ruffner bank, the seam shows an identical section. The coal is free from partings, and is of a firm, bright appearance. South of the Ruffner bank is another old bank, No. 632. Farther east, toward the head of Spra Run, the coal has been worked at two points, Nos. 633 and 634, and at No. 634 is 2 feet 7 inches thick (Pl. VIII, 69).

Still farther east, in the valley of Huskins Run, the coal is worked at the Moses Beer bank, No. 635, and is 2 feet 4 inches thick. In the Boyer well (416) and in the P. Rearick well (417), in Plum Creek Township, the coal was noted at depths of 420 and 200 feet, respectively. In the road on Huskins Run, 1 mile north of the mouth, No. 636, the Lower Freeport is exposed over 1 foot thick, and within 1 mile south of Greendale are two old banks, Nos. 637 and 638 North of Cowanshannock Creek the coal was reported to have been opened on the farm of J. M. Schreckengost, No. 639, above the junction of Mill Run. About 1 mile north of this point this seam was penetrated in the William Brunt well (351), 143 feet deep, and reported as the 3-foot vein, possibly denoting that it is 3 feet thick. In a ravine one-half mile east of the Rayburn-Valley boundary is an old opening by the roadside, No. 640, and near the road in a ravine one-half mile farther east the coal is worked on the Robinson farm, No. 641, where it is reported 2 feet 6 inches to 3 feet thick and of excellent quality. Near the head of the ravine three-fourths mile southwest of West Valley the coal is exposed by the stream, No. 642, and has about the thickness given above. Near by Nos. 643 and 644 are old openings. About 1 mile southeast of West Valley the coal is opened by the roadside on the Adams farm, No. 645, and is 2 feet 6 inches thick (Pl. VIII, 70). Near the head of Long Run the Lower Freeport coal makes a good showing in the road, No. 646, and three-fourths mile to the southeast it is worked at Henry Bear's bank, No. 647, and shows the following section:

Lower Freeport coal at Bear's bank, Long Run, No. 647 (Pl. VIII, 71).

	Ft.	in.
Coal	2	
Parting (thin).		
Coal		8
	2	8

In a ravine about 1 mile northwest of Yatesboro, No. 648, the coal is opened, and a thickness of 2 feet is reported. At the Yatesboro No. 2 mine the coal was opened beneath sandstone. It is 30 feet below the Upper Freeport coal and is reported 2 feet 9 inches thick. This seam was penetrated in the following wells north of Yatesboro:

Lower Freeport coal in wells north of Yatesboro.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
P. & J. Brown (475)	165	5
Lynes (476)	180	3
William Schreckengost No. 1 (461)	240	4

UPPER FREEPORT COAL.

The Upper Freeport is a good coal throughout the basin and has a great extent of outcrop in the western half. In the eastern half it is under deep cover and lies nearly flat. At the Galbreath bank, northeast of Kittanning, No. 649, the seam has the following section:

Upper Freeport coal at Galbreath bank, No. 640, northeast of Kittanning (Pl. VIII, 105).

	Ft.	in.
Coal, with knife-edge partings	3	
Bone		2
Coal		10
	4	

Analysis No. 22 (p. 98) gives the composition of the coal at this bank. About one-half mile to the east, No. 650, is another opening, at which the seam has the following section showing a great change from its excellent condition in the Galbreath bank:

Upper Freeport coal northeast of Kittanning, No. 650 (Pl. VIII, 106).

	Ft.	in.
Coal	2	
Shale		2
Coal		6
	2	8

The coal has been worked in the ravine east of the old mill 1 mile above the mouth of Cowanshannock Creek, No. 651, and also at the Fritz bank about 1 mile to the south, No. 652, where the seam presents the section given below:

Upper Freeport coal at Fritz bank, northeast of Kittanning, No. 652 (Pl. VIII, 107.)

	Ft.	in.
Coal		2
Thin parting.		
Coal		2
Thin parting.		
Coal		5
Parting		½
Coal	1	
Parting		½
Coal		3
Parting		½
Coal		7
Parting		½
Coal	2	
Parting		1
Coal		6
	5	4

Three-fourths mile southeast of the Fritz bank is an old opening, No. 653, and near by the coal makes a good showing in the road. At the Allison bank, on the Clearfield pike 2 miles east of Kittanning, No. 654, the following section is reported:

Upper Freeport coal at Allison bank, east of Kittanning, No. 654 (Pl. VIII, 108).

	Ft.	in.
Coal	2	8
Coaly shale		2
	2	10

The coal here is reported to swell locally to a thickness of 3 feet 10 inches. Near the Allison bank No. 655, the coal has been opened recently, and on the north side of the creek one-half mile above is an old opening, No. 656. In a ravine on the south side of Cowanshannock Creek three-fourths mile below Mill Run is a bank, No. 657, at which the coal is 3 feet 4 inches thick, with occasional thin clay partings, and near this bank to the southward are old openings, Nos. 658, 659. In a ravine north of the creek opposite the one just

described the coal is of good thickness. Near the mouth is an old opening, No. 660, and a short distance north is the Stewart bank, No. 661, at which the following section was measured:

Upper Freeport coal at the Stewart bank, southeastern Rayburn Township, No. 661 (Pl. VIII, 109).

	Ft.	in.
Coal	2	4
Parting.		
Coal		10
	3	2

Near the head of this ravine is the Miller bank, No. 662, at which the coal is above the average thickness, as shown by the following section:

Upper Freeport coal at the Miller bank, eastern Rayburn Township, No. 662 (Pl. IX, 110).

	Ft.	in.
Bone		3
Coal	2	2
Parting		½
Coal	1	10
	4	3½

On the hillside south of Mill Run one-half mile above its mouth is an old opening, No. 663, and on the opposite side of the run to the east are several others, No. 664, indicating that considerable coal has been dug. On the hill one-half mile east of McNees is the Daniel Rosenberger bank, No. 665, at which the following section was measured:

Upper Freeport coal at the Rosenberger bank, Mill Run, No. 665 (Pl. IX, 111).

	Ft.	in.
Coal with two or three thin partings		8
Coal	2	
Clay		½
Coal		11½
	3	8

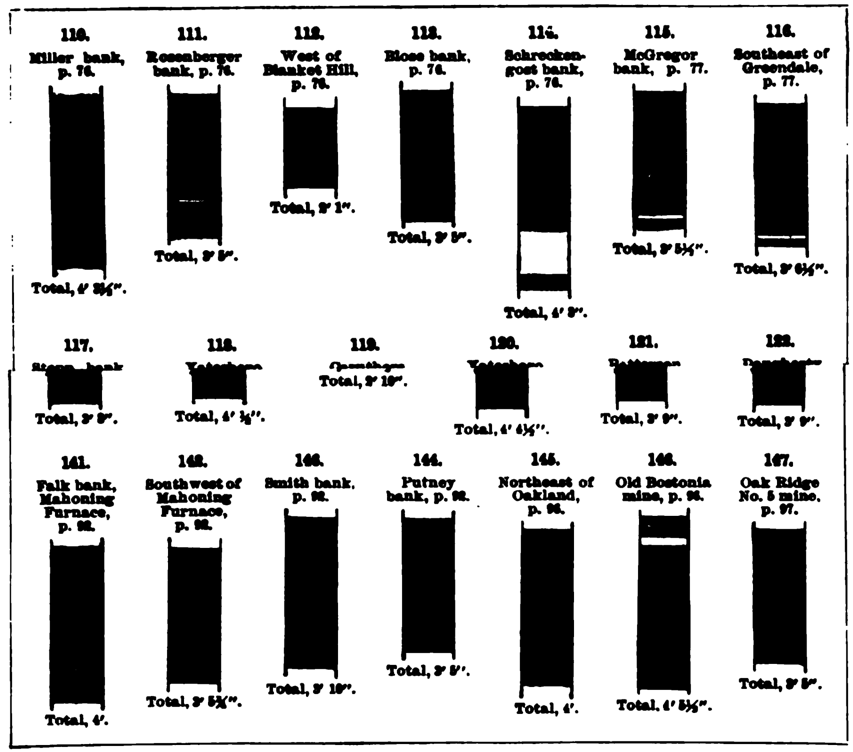
One-half mile south of McNees the blossom of the coal shows in the road, No. 666, and in a ravine one-half mile southeast of this point is an opening, No. 667, at which the coal is reported 4 feet thick. This opening is about 60 feet above the stream bed, where the Lower Freeport coal is exposed at No. 628, and this affords a good measure of the interval between the two seams. In the next ravine west of Blanket Hill near the crossing of the Indiana pike, No. 668, the coal is exposed in the road and 3 to 4 feet thick, and on the east side of the run, No. 669, the coal is opened and is 2 feet 1 inch thick (Pl. IX, 112). The coal here is immediately overlain by the Mahoning sandstone, which is coarse and thick all over the region between this point and Cowanshannock Creek. To the north along the ravine is an old opening, No. 670, and about 1½ miles to the east near the head of Mill Run is another, No. 671.

In the McElroy well (316) southeast of Blanket Hill what is probably this coal is reported 3 feet thick at the depth of 70 feet. Southeast of this well is the Blose bank, No. 672, at which the coal is 3 feet 5 inches thick (Pl. IX, 113).

North of Cowanshannock Creek, above the mouth of Mill Run, the coal is worked on the J. M. Schreckengost farm, No. 673, where the following section was measured:

Upper Freeport coal at the Schreckengost bank, eastern Rayburn Township, No. 673 (Pl. IX, 114).

	Ft.	in.
Coal	3	2
Shale	1	2
Coal		4
	4	8



COAL SECTIONS.

Sections 110 to 147, Upper Freeport coal.

The coal here is overlain by about 10 feet of shale and this in turn by Mahoning sandstone. One-half mile north of the Schreckengost bank is an old bank, No. 674, and still farther north is the McGregor bank, No. 675, where the following section was obtained:

Upper Freeport coal at the McGregor bank, Valley Township, No. 675 (Pl. IX, 115).

	Ft.	in.
Coal	2	3
Parting		½
Coal		10
Shale and bone		2
Coal		2
	3	5½

In a ravine three-fourths mile east of the Rayburn-Valley boundary, on the Robinson farm, No. 676, springs were pointed out as indicating the outcrop of this seam, and near the head of the next ravine on the east, No. 677, another spring was believed to indicate its presence. Near the head of the ravine south of Cowanshannock Creek, 1 mile southwest of Stone House, No. 678, the coal has been stripped and a thickness of 1 foot 6 inches was exposed immediately beneath the Mahoning sandstone. On the opposite side of the spur to the north overlooking Cowanshannock Creek, No. 679. is an old opening. On the crest of the spur between Spra Run and Cowanshannock Creek, No. 680, the coal has been opened and is reported 4 feet thick, but under too thin cover to be workable. In the northeast corner of Kittanning Township is an old opening, No. 681, and a bank, No. 682, the exact location of which is uncertain. Near the head of Spra Run is an old opening, No. 683, at which the coal is reported 2 feet thick. In the Collum well (321) near this point the coal is reported 4 feet thick at the depth of 100 feet. Near the head of the ravine running north from Stone House is an old opening, No. 684, and a working bank, No. 685, on the Barker farm. Near the head of Long Run, No. 686, the blossom of the coal was observed where a ditch had been dug for a pipe line; on the spur 1 mile northwest of Greendale, No. 687, abundant débris of the coal was noted, and there is an opening at No. 688. About 1 mile north of Greendale is an old opening, No. 689, and a bank, No. 690, at which the coal is 3 feet 9 inches thick. Near the road in the ravine south of Cowanshannock Creek one-half mile above Greendale is an old bank, 691, at which the following section was measured:

Upper Freeport coal southeast of Greendale, No. 691 (Pl. IX, 116).

	Ft.	in.
Coal	2	4
Parting		½
Coal		6
Parting		½
Coal		4½
Parting		1½
Coal		1½
	3	6½

Near the point of the spur north of this bank, No. 692, is a working bank, and on the east side of the spur, No. 693, is a bank on the Rosenberger farm, at which the seam is 3 feet 8 inches thick.

Proceeding up Huskins Run an old opening is reached, No. 694. Opposite on the east is a working bank, No. 695, and still farther up are three openings, No. 696, at which the coal is reported 4 feet thick. At Blanco are openings of the Yatesboro No. 1 mine, No. 697. In the ravine to the west of Blanco are old openings, No. 698, and just above at water level, No. 699, the blossom of the coal was seen. Farther west are the McCurdy bank, No. 700, at which the coal is 4 feet thick, and the Stepp bank, No. 701, at which it is 4 feet

3½ inches thick (Pl. IX, 117). A coal seam identified as the Upper Freeport has been penetrated in deep wells of this section of the basin as follows:

Upper Freeport coal in wells in Cowanshannock basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
S. & A. McCurdy No. 1 (432)	155	4	A. A. Marshall (424)	70	3
S. & A. McCurdy No. 2 (431)	159	....	W. C. Devinney (425)	265	5
John Boyer (416)	360	....	James Peters (445)	270	....
John Bell (419)	285	....	J. A. Bowser (443)	155	4
N. H. Duff (421)	294	5	H. Wampler (441)	200	5
Caroline Fisher (423)	75	5			

The Upper Freeport coal is mined on a large scale at Yatesboro by the Rochester and Pittsburg Coal and Iron Company. It crops out on Plum Creek about 2 miles south of Atwood, in the Elders Ridge quadrangle, and at a bank thicknesses of 2 feet 10 inches and 3 feet 6 inches were measured. The coal is also shown to be of good thickness in a number of diamond-drill holes in that locality. Platt collected samples from the Beers bank, in the vicinity of Blanco, which were analyzed with the result shown in No. 28 of the table on page 98. At the Yatesboro No. 1 mine the following section was obtained:

Upper Freeport coal at Yatesboro No. 1 mine (Pl. IX, 118).

	Ft.	in.
Coal		4
Parting		6¾
Coal		¾
Parting		3
Coal	4	4½
	5	6¾

The similarity of this section to the one given below, taken from Platt,[a] suggests that his section was measured at the same point:

Upper Freeport coal on the Caruthers property, west of Rural Valley (Pl. IX, 119).

	Ft.	in.
Coal		4
Slate		10
Coal	2	9
Slate (thin).		
Coal		8
Slate		½
Coal		9
	5	4½

The coal undergoes a marked change in crossing the creek about 1 mile to the northeast, where it has the following section at the Yatesboro No. 2 mine:

Upper Freeport coal at Yatesboro No. 2 mine (Pl. IX, 120).

	Feet.
Bony coal	1
Coal	3
	4

This section is also almost identical with that published by Platt[a] of his so-called Gallitzin coal:

Upper Freeport (Gallitzin) coal at Patterson mine (Pl. IX, 121).

	Ft.	in.
Slate, gray and black	1	
Coal	3	1
	4	1

[a] Second Geol. Survey Pennsylvania, Rept. HH, p. 91.

Platt published an analysis of the coal at this bank, which is given in No. 27 of the table (p. 98). The seam mined at Yatesboro No. 2 is called Gallitzin by some, who maintain that it is 50 feet above the Upper Freeport coal, but, as shown on page 38 of this bulletin, that contention can hardly be sustained.

The Upper Freeport coal dips beneath water level at Yatesboro, and is at a considerable depth below the surface throughout all the southwest corner of the quadrangle. North of Cowanshannock Creek it is recorded in deep wells, as follows:

Upper Freeport coal in wells north of Cowanshannock Creek.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Crow No. 1 (452)	282	2	William Schreckengost No. 2 (463)	90	3
Gourley heirs (453)	150	4	William Schreckengost No. 3 (464)	100	4
Daniel Schreckengost (455)	80	4	Brown (473)	150	4
Jerry Elgin No. 2 (460)	105	5	Kelly heirs (480)	230	7
William Schreckengost No. 1 (461)	165	4	Samuel Moore (485)	80	4

BRUSH CREEK COAL.

The Brush Creek coal is almost exactly 100 feet above the Upper Freeport coal in this locality, and occupies the position of the Gallitzin coal in Cambria County, as before noted (p. 38). This interval is shown in the record of the Brown well (473), north of Rural Valley, in which the depth of the Brush Creek coal is 50 feet and that of the Upper Freeport coal 150 feet. This Brush Creek coal shows in the road, just east of Rural Valley, No. 702, and is about 1 foot thick. It was opened farther east, near the margin of the quadrangle, No. 703, and reported 1 foot 8 inches thick. It makes a good blossom along the road north of Smeltzer, No. 704.

COALS IN PINE CREEK BASIN.

BROOKVILLE COAL.

The Brookville coal makes a good showing in the road about 2 miles west of Oscar, No. 705, and what is probably the same coal is noted in the records of a number of wells in the basin, as follows:

Brookville coal in wells in Pine Creek basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
J. & F. Powers (361)	60	2	A. Heffelfinger (377)	80	4
J. Carson (482)	310	5	J. A. White No. 2 (516)	274	6
Stoops (503)	185	3	Rebecca Martin No. 2 (514)	150	3

It is to be remarked concerning the last two wells that there is great uncertainty as to the identification of the coal noted, but it is thought to be of interest as well as of possible value to state the facts of depth and thickness, whatever the seam may be in each case.

CLARION COAL.

Nothing is known of the Clarion coal in this basin save possibly in the records of two wells, namely, the J. E. B. Mateer well No. 3 (370), on North Fork 1½ miles above the mouth of Bullock Run, and the J. W. Halderman well (512), below Muff. In the former a coal at the depth of 190 feet and in the latter a coal at the depth of 108 feet and 3 feet thick may be the Clarion seam.

LOWER KITTANNING COAL.

The Lower Kittanning coal has a considerable extent of outcrop in this basin—more, however, along South Fork than along North Fork. It is of good thickness near the mouth of the creek, but is immediately overlain by the Kittanning sandstone, which is coarse and 20 feet thick. It has been opened at a few points near the junction of the two forks, Nos. 706 to 708. At the first point the coal is 3 feet thick and at the last two points are old openings now closed. On South Fork it probably outcrops at about water level from the junction of the forks to a point one-half mile west of Pine Furnace; then its outcrop rises to the axis of the Greendale anticline, whence it descends to water level one-half mile west of Echo. It is exposed along two of the ravines northeast of Echo, running northward toward the axis of the Greendale anticline. The seam appears to be of good thickness along this stream, but little is known of its character. In the vicinity of Pine Furnace, No. 709, Platt reports the coal to be 2 feet 6 inches thick (Pl. VI, 29). In the ravine on the north just above Pine Furnace, No. 710, the coal has been worked to some extent, and at J. W. Gillis's bank above Pine Furnace, No. 711, it is reported to be 4 to 6 feet thick, separated into two benches by a layer of clay 1 foot thick. This bank was unfortunately flooded and inaccessible at the time of the writer's visit and this made it impossible to examine the coal. The seam is opened north of Oscar, No. 712, and is 2 feet 11 inches thick (Pl. VI, 30), and still farther north is another opening, No. 713, now closed. One mile northeast of Echo is an old opening at road level, No. 714, that may be in this coal. One and a half miles southwest of Belknap, No. 715, and the same distance to the southeast, No. 716, are old pits in this seam. On North Fork the coal outcrops for one-half mile above the mouth; it is then under cover for 2½ miles across the Fairmount syncline, and then outcrops again for 3 miles west of the axis of the Greendale anticline. But a single opening was noted, 1 mile east of Slabtown, No. 717. It is recorded in the following wells:

Lower Kittanning coal in wells in Pine Creek basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
A. Bowser (472)	260	....	Rebecca Martin No. 1 (515)	150	3
H. Slease No. 3 (358)	160	4	Stockdill No. 2 (521)	104	4
Robert Martin No. 1 (365)	80	4	John Snyder (522)	100	3
Mateer No. 1 (374)	210	4	Stockdill No. 3 (523)	100	2
J. A. White No. 2 (516)	140	4			

MIDDLE KITTANNING COAL.

The Middle Kittanning seam promises to be of value in the eastern part of Pine Creek basin. Its blossom shows in the road north of the junction of North and South forks, No. 718. On North Fork it has been stripped at the mouth of a ravine on the north 1½ miles west of Slabtown, No. 719, and it is here about 2 feet thick. South of Slabtown, No. 720, the seam is exposed by the roadside and is apparently 3 feet thick. About one-half mile west of Muff, No. 721, is a good blossom apparently made by this seam. On the north branch of South Fork above Echo this coal becomes of considerable importance. Platt[a] published the following section obtained at a bank on the Kline farm, between Echo and Belknap:

Middle Kittanning coal on Kline farm, between Echo and Belknap (Pl. VII, 46).

	Ft.	In.
Coal	3	5
Slate	1	
Coal	1	7
	6	

[a] Second Geol. Survey Pennsylvania, Rept. HH, p. 115.

The location of this opening can not be determined with certainty from Platt's description, but it is possibly just north of the road 1½ miles above Echo, No. 722, where there is an old bank at which the coal is reported thick and where it appears to have been rather extensively dug. Near the point just described is a working bank, No. 723, in which the coal is good and 2 feet 8 inches thick (Pl. VII, 47). On the opposite side of the branch to the south is an old opening, No. 724, and about three-fourths mile farther up the branch, No. 725, is another old bank at which the coal is reported 2 feet 4 inches thick. Still farther up the branch, 1¼ miles west of the quadrangle boundary, near the point where the coal goes under the stream, No. 726, is an old opening at which the coal is reported 5 feet thick, and on the south side of the branch opposite, near railroad level, are a number of old openings, No. 727. These workings indicate that the Middle Kittanning seam is of minable thickness over a considerable area along the north branch of South Fork of Pine Creek. What appears to be this coal is noted in the following wells in the Pine Creek basin:

Middle Kittanning coal in wells in Pine Creek basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
J. Carson (482)	125	5	Concord Church (524), near Muff.	190	....
Laura Pontius (499)	170	....	Joseph Clever No. 2 (525)	100	2
William Wadding (500)	220	....			

UPPER KITTANNING COAL.

The Upper Kittanning coal is of good thickness in this basin as far east as Pine Furnace and Slabtown. It has been opened at two points near the junction of the forks of Pine Creek, one of which is in the ravine to the north, No. 728, where it is close beneath the Freeport sandstone and apparently about 3 feet thick, and the other is near the road on the point of the spur between the two forks, No. 729. There is a large blossom at two points in the road along South Fork, Nos. 730 and 731, and a thickness of 2 to 3 feet of coal is indicated.

In the ravine just beyond, the coal has been opened at two points, Nos. 732 and 733, and also in the ravine to the south, No. 734. About one-half mile farther up the creek, No. 735, is an old mine at which the coal was extensively mined for coke for use at Pine Creek Furnace. One-half mile above this are two old workings, No. 736. It is probably at the eastern one of these that Platt [a] obtained the following section:

Upper Kittanning coal at Pine Furnace (Pl. VII, 55).

	Ft.	in.
Coal	1	10
Slate and bony coal		1
Coal		9
	2	8

Mr. John Painter, superintendent of the works at Pine Creek Furnace, reports the coal to be of good quality, but expensive to mine because it is cut out to considerable extent by the overlying Freeport sandstone, which appears to be heavy over much of this region. The coal mined at these points was coked in open pits at the furnace with good results. This seam was regarded as the Lower Freeport, but its stratigraphic relations indicate rather that it is Upper Kittanning. In the ravine on the north just above Pine Creek Furnace, No. 737, the coal is exposed and is about 2 feet thick. There is an old opening on the east side of Deaver Run, No. 738, that is probably in this coal, and at the head of the

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 123.

run, Nos. 739 and 740, the coal is partly exposed and appears to be over 1 foot thick. On the road southwest from Oscar the coal shows at No. 741, and near by is an old pit. At Echo this seam is of minable thickness and considerable coal is taken out at the Beck bank, No. 742, at which the following section was measured:

Upper Kittanning coal at the Beck bank, Echo, No. 742 (Pl. VII, 56).

	Ft.	in.
Coal	1	4
Shale		1½
Coal	1	3
	2	8½

Beyond this point nothing further is known of the coal in outcrop on South Fork. On North Fork it has been opened beneath the Freeport sandstone at the mouth of Bullock Run, No. 743, and is over 2 feet thick. In the road north of Slabtown, No. 744, its outcrop indicates a thickness of 2 feet, and just across the ravine to the east is an old opening, No. 745, at which it is reported 2 feet 6 inches thick. Just south of Slabtown, No. 746, and still farther south opposite the head of Deaver Run, No. 747, are old openings. A seam identified as Upper Kittanning is reported in the following wells:

Upper Kittanning coal in wells in Pine Creek basin.

Name of well.	Depth.	Thickness.	Name of well.	Depth.	Thickness.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Ben Hill No. 1 (468)	142	3	N. H. Rupp (501)	165	5
Alec Brice No. 1 (498)	110	5	Mateer No. 1 (374)	100	4

It is highly probable that there is a workable body of Upper Kittanning coal of considerable extent between the forks of Pine Creek west of a line connecting Slabtown and Oscar, and this may be connected with the workable area in the vicinity of Rural Valley.

LOWER FREEPORT COAL.

The Lower Freeport coal does not appear to be present in any thickness in the lower part of this basin. Its blossom was observed, however, in the road north just above the junction of the two forks, No. 748, and in the road on the point of the spur between the two forks, No. 749. In the ravine south of Pine Furnace it makes a good showing in the road, No. 750, and it has been dug in a western branch of the ravine on the north just above Pine Furnace, No. 751, where considerable coal débris shows in the stream and the Lower Freeport limestone underlies the coal. In the second ravine on the south above Pine Furnace is an old opening, No. 752, and on the point of a spur 1 mile east is another, No. 753. Along Deaver Run it has been opened on the east, No. 754, and near the head of the run, No. 755, it is exposed in the road and is 2 feet or more in thickness. Its blossom was seen in the road one-half mile south of Oscar, No. 756, and 1 mile east it has been opened on the hillside, No. 757, and is 2 feet 6 inches thick (Pl. VIII, 72) two miles east, in the ravine south of Echo, are openings, Nos. 758, and 759. Just north of Echo it shows in the road, No. 760, and still farther north, No. 761, is a bank at which the coal is 2 feet 5 inches thick. On the ridge between this ravine and the next on the east the coal makes a large showing in the road, No. 762.

On North Fork it was observed near the mouth of Bullock Run, No. 763, 6 inches thick, but nothing was seen of it between this point and the vicinity of Muff, where it reappears on the hills to the north. It makes a large showing at several points on the hills northwest of Muff, Nos. 764 to 766, and has been opened on the ridge to the northeast, No. 767. Nothing definite, however, was learned concerning the thickness and character of the seam in this locality.

UPPER FREEPORT COAL.

The Upper Freeport coal appears to be generally good throughout the basin. South of South Fork it has been worked to some extent in a ravine west of Pine Furnace. There is an old bank, No. 768, and a working bank on the Daugherty property, No. 769, at which the following section was measured:

Upper Freeport coal at the Daugherty bank, southwest of Pine Furnace, No. 769 (Pl. IX, 122).

	Ft.	in.
Coal	2	
Bone		½
Coal		11½
Bone		2
Coal		6½
	3	6½

At an opening in the ravine south of Pine Furnace, No. 770, the coal is 2 feet to 2 feet 3 inches thick (Pl. IX, 123) and one-half mile south, No. 771, the coal is exposed in the road and is 2 feet or more thick. The coal in this ravine is overlain by sandstone and shows a great thinning between this locality and the Daugherty bank. Near the head of the ravine just northeast of Pine Furnace, No. 772, abundant coal débris, clay, and springs indicate the position of the seam. Near the head of Deaver Run, No. 773, its blossom was seen in the road. Near the point of a spur just west of West Valley, No. 774, an opening had been started, but had not been driven in beneath rock cover. About 1 foot of coal was exposed and fragments of limestone had been thrown out, indicating that the coal is Upper Freeport. At the head of the ravine to the east, No. 775, the coal was reported in the cellar of a house. On the point of a spur 1 mile northeast is an old opening, No. 776, 50 feet above an opening into the Lower Freeport coal. One mile southwest of Oscar are two old openings, Nos. 777 and 778, and just over the divide beyond the coal makes a good showing in the road, No. 779. Near the head of a ravine about 1½ miles east of Oscar, No. 780, is an old opening, and at the head of the next ravine to the east, south of Echo, No. 781, is a bank at which the coal is 3 feet 9 inches thick (Pl. IX, 124). Still farther east in the ravine followed by the railroad to Yatesboro is Cook's bank, No. 782, at which the coal has the section given below:

Upper Freeport coal at Cook's bank, southeast of Echo, No. 782 (Pl. IX, 125).

	Ft.	in.
Coal, slaty		10
Parting		½
Coal	3	6
	4	4½

At the Carson bank three-fourths mile west of Bryan, No. 783, 2 feet 10 inches of coal were seen and the coal is reported 4 feet to 4 feet 2 inches thick; just across the branch to the north is an old opening, No. 784, and in a ravine to the northwest, No. 785, is another. Somewhere in this neighborhood, apparently, Platt[a] obtained the following section:

Upper Freeport coal at McIlwain farm and at Cook farm, Echo (Pl. IX, 126).

	Ft.	in.
Coal	3	8
Slate		1
Coal		4
	4	1

On the spur 1 mile north of Oscar, No. 786, the seam is worked and is 4 feet thick (Pl. IX, 127).

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 111.

In the road north of Echo, No. 787, the blossom of the coal was seen, and on the ridge farther north, No. 788, the coal is opened at two points, at one of which, on the Brown & Mosgrove property, the coal is 4 feet thick with irregular thin partings. On the knob three-fourths mile southeast of Muff, No. 789, is a bank and a little to the east of this point the coal makes a large showing in the road, No. 790. On knobs 1 to 2 miles east of Muff the coal is present and of good thickness. At No. 791 it makes a good showing in the road, and on the knob about 1 mile east is a bank, No. 792. The Freeport limestone outcrops in the road at No. 793, and the blossom of the coal shows in the road to the north, No. 794. On a knob north of North Branch, 2 miles northeast of Echo, No. 795, the coal makes a large showing in the road. One mile farther east, No. 796, the Freeport limestone is reported in a well and near by is a prospect pit for the coal. Little could be learned of the coal south of North Branch. In the side valley above Echo clay and springs were observed, Nos. 797 and 798, that probably indicate the position of the seam; 1 mile to the northeast, No. 799, its blossom was seen; just to the north of this point, No. 800, is an old pit; and one-half mile farther north on the north side of the spur, No. 801, coal débris was seen that may come from this coal, though the position is rather low. Near the head of North Branch the coal shows near the stream level, No. 802, to the north the coal makes a good showing in the road, No. 803, and near by, No. 804, are two banks at one of which the coal is 4 feet thick (Pl. IX, 128).

Just over the hill from this point, in the Mahoning basin, No. 805, is another old opening associated with a limestone quarry. There is doubt as to whether the coal is present, as mapped, beneath the flat land just to the southwest of the last-described points, but the structure and topography seem to indicate that it is, though it is probably under too thin cover and too much weathered to be of any value. On the knob to the west, No. 806, the coal is exposed in connection with a limestone quarry, and on the knob southwest of this point, No. 807, there is another limestone quarry and probably the coal is present, but under thin cover.

On North Fork of Pine Creek the coal has been opened in the ravines north of the junction of the forks, Nos. 808, 809. In the road on the point of the spur between the two forks, No. 810, the coal is exposed and about 1 foot 6 inches was seen. On Bullock Run the coal has been opened at several points, Nos. 811 to 814. At No. 811 is a working bank beneath the Mahoning sandstone; at the other points are old workings. At the bank the following section was obtained:

Upper Freeport coal on Bullock Run, No. 811 (Pl. IX, 129).

	Ft.	in.
Coal		6
Parting		¼
Coal		2
Parting		¼
Coal		3
Parting		¼
Coal	1	7
	2	6¾

On North Fork about 1 mile above the mouth of Bullock Run the blossom of the coal was seen in the road on the south, No. 815, and in the ravine just above on the north its limestone is quarried, No. 816, and its blossom was seen, Nos. 817 and 818. In the ravine next eastward the coal has been opened in several places, Nos. 819 to 823. At No. 823 it is 3 feet and at No. 821 it is 3 feet 8 inches thick (Pl. IX, 130). It also shows in the road at No. 824. About 1 mile northeast of Slabtown it shows in the road, No. 825, and has been opened at No. 826. In the G. W. Sowers well (384) at this point the coal was penetrated at the depth of 80 feet and reported 4 feet thick. On the knob three-fourths mile south of Slabtown, No. 827, is a bank and on the knob 1½ miles northeast, No. 828, is an old opening. East of Muff the coal occurs only in small patches on the tops of the highest knobs, the last outlier being on the high knob at Concord Church, in which are two banks, Nos. 829 and 830. At the latter, known as the Bowser bank, the coal is 4 feet 4 inches thick (Pl. IX, 131).

BRUSH CREEK COAL.

The Brush Creek coal shows at a few points along the ridge road in the vicinity of West Valley, Nos. 831 to 835. At these points a thickness of 2 feet or more is indicated. At the first is an old pit that may have been dug in search of this coal, but probably is too low for it.

COALS IN THE MAHONING BASIN.

BROOKVILLE COAL.

The blossom of the Brookville coal was seen in the road north of Dee, No. 836, and a thickness of 2 feet is indicated. In the valley near the road crossing east of Kellersburg, No. 837, the coal is apparently over 1 foot thick. It reaches a good development along the upper part of Mahoning Creek within the quadrangle. At the mouth of the ravine known as Sandy Hole, which enters Mahoning Valley about 2 miles below Putneyville, No. 838, the coal is exposed and exhibits the section given below:

Brookville coal below Putneyville, No. 838 (Pl. VI, 3).

	Ft.	in.
Coal	1	5
Shale	1	
Coal	1	5
	3	10

About 1 mile below the mouth of Sandy Hole, No. 839, a coal 4 feet thick, with an 8-inch parting in the middle, which is evidently Brookville, is reported near creek level. In the bluffs at the point of the big bend below Putneyville, No. 840, this coal has been faced up by Mr. Miles Putney, and shows the following section:

Brookville coal at the big bend below Putneyville, No. 840 (Pl. VI, 4).

	Ft.	in.
Coal	1	3
Hard binder		8
Coal	2	5
	4	4

This coal is very hard, brittle, and lusterless. Nothing is known as to its chemical composition or fuel qualities. Near the dam at Putneyville, No. 841, this coal has been dug to some extent. South of Eddyville it has been opened in a ravine, No. 842, and on the Bittinger property on Camp Run farther south, No. 843. At the last point two benches are reported, the upper of which was worked. In the Daniel West well (535), 3 miles south of Eddyville, this coal was reported 6 feet thick at 129 feet, and in the Conrad Berline well (529), east of Belknap, it is reported 3 feet thick at 139 feet. Northeast of Eddyville on Pine Run, No. 844, the coal is exposed in the bank of the ravine below the road. At this point it shows the same section as given above, but has dwindled to less than half the thickness.

Brookville coal on Pine Run, No. 844 (Pl. VI, 5).

	Ft.	in.
Coal		10
Hard binder		2
Coal		8
	1	8

Still farther up Pine Run, just below McWilliams, No. 845, a hard, brittle coal is exposed at the base of a heavy sandstone. About 2 feet was seen. It is probably the Brookville. These observations indicate the probability of a good body of this coal along upper Mahoning Creek, and the further fact that what appears to be this same bed is noted of good thickness in several wells on North Fork of Pine Creek below Muff, as already described, suggests the possibility that the bed underlies the intervening territory. The indications would appear to justify prospecting at least.

CLARION COAL.

The Clarion coal was noted at only a few points and everywhere as a thin bed. It shows in the road north of Dee, No. 846, and in the ravine east of Deanville it is exposed and is 1 foot thick. In the W. H. Kuhns well (395), at Goheenville it is reported 2 feet thick at the depth of 90 feet. It is apparently of no value in this basin.

LOWER KITTANNING COAL.

The Lower Kittanning seam varies much in thickness in different parts of the Mahoning basin. It is mined at the Mahoning colliery north of Mahoning, and at a bank about one-half mile north of this point, No. 847, the seam is 2 feet 8 inches thick (Pl. VI, 31). Analysis No. 2 (p. 98) is of a sample of the coal from this locality. About the head of the ravine southeast of Widnoon are a number of old banks, Nos. 848 to 851. On the east side of this ravine, No. 852, is a new opening in which the coal is 2 feet thick. The opening has not been driven deep enough, however, to obtain the full thickness of the seam. Near by, No. 853, is an old opening. In a ravine three-fourths mile southeast of Dee, No. 854, the coal is exposed beneath dark shale, and is 2 to 3 feet thick. Along Scrubgrass Creek the coal is near water level as far east as Goheenville. There is evidence that it has been stripped at the mouth of a ravine on the south 2 miles above the mouth, No. 855, and just above No. 856, the coal is exposed at creek level at the mouth of a ravine on the north and is 2 feet 6 inches thick (Pl. VI, 32).

The coal at this point is immediately overlain by about 30 feet of soft black shale and that in turn by a heavy sandstone, a section that is characteristic of the locality. About three-fourths mile below Goheenville, No. 857, the coal is 2 feet 2 inches thick (Pl. VI, 33), and is opened beneath black shale, which is overlain by 20 feet of heavy sandstone. It was noted in the following wells in the vicinity of Goheenville:

Lower Kittanning coal in wells near Goheenville.

Name of well.	Depth.	Thickness.
	Feet.	*Feet.*
J. Brosius No. 2 (397)	289	4
Houser heirs (393)	260	4
J. P. Kammerdiener (392)	35	4

At Goheenville is an old pit, No. 858, and 1 mile east of town the blossom of the coal was seen in the road, No. 859. Near Kellersburg is an old opening, No. 860, and a working bank on the Bish farm, No. 861, at which the section below was measured:

Lower Kittanning coal at the Bish bank, Kellersburg, No. 861 (Pl. VI, 34).

	Ft.	in.
Bone		5
Coal	1	2
Parting		½
Coal	1	2
	2	9½

The miner at this bank reported that the seam yielded on the average not over 2 feet of good coal. At the head of the valley east of Kellersburg are two old openings, Nos. 862, 863. Near the mouth of the ravine south from Deanville, No. 864, the coal was exposed in a side ravine to the thickness of 1 foot 6 inches. The coal was not seen between the mouth of this ravine and Mahoning Furnace, but in the ravine to the north of that point it shows as a thin bony bed, No. 865. Its blossom was noted 1½ miles to the southwest of Mahoning Furnace, No. 866. Near the mouth of Sandy Hole, below the big bend at Putneyville, the coal has been worked on the Schreckengost property, No. 867, but the opening was

flooded and the writer could not examine the coal. The seam was reported to yield only about 1 foot 8 inches of good coal, which is said to be excellent for steaming purposes. In a ravine northwest of Putneyville, No. 868, the seam is reduced to 6 inches in thickness, but at the forks of Cathcart Run north of Putneyville, No. 869, the coal is reported on good authority to be 2 feet 6 inches thick. At Foreman's bank southeast of Putneyville, No. 870, the coal is 3 feet 6 inches thick (Pl. VI, 35).

This shows a great improvement in the coal from its condition below Putneyville. The coal undergoes a great change one-half mile to the south of Foreman's bank, where the following section was exposed in the road, No. 871:

Section in road near head of run in the southeast corner of Mahoning Township, No. 871.

	Feet.
Coal	2
Clay	6
Limestone	2
Shale	5
Coal	1½ to 2
Clay	6
Shale	4
Sandstone	1
Shale	1
Sandstone	3
Coal	1
Shale	10
Concealed	10
Vanport limestone.	

It is somewhat difficult to interpret such a section as this. The lower and middle coals fall within the usual limits of the Lower Kittanning coal above the Vanport limestone, but the upper coal is higher above the limestone than the Lower Kittanning is known elsewhere in the quadrangle, yet the interval is less than that known between the Vanport limestone and the Middle Kittanning coal. The assumption, therefore, that these thin beds really represent the Lower Kittanning coal split into three benches seems the most probable. Such cases are known to occur elsewhere in this and other seams, and may be the result of local rapid deposition of sediment during the accumulation of the coal seam which interrupted the continuity of the accumulation.

On the bluff of the Mahoning 1 mile southeast of Eddyville, No. 872, is an old opening and about 1 mile to the south the coal shows in the road, No. 873. On the forks of Camp Run it has been opened at several points, Nos. 874 to 876, and its blossom shows at Nos. 877 and 878. On the hill overlooking the gorge of Glade Run, No. 879, is an old bank at which the coal is reported 3 to 4 feet thick, and 1½ miles northeast on the bluff of Mahoning Creek is another opening, No. 880. In the Jewell heirs well (532), on the brow of the south bluff of Mahoning Creek, the coal is reported 3 feet thick at 36 feet, and in the A. H. West well (533) near by it is reported at 28 feet. On the hill, 1 mile south of Eddyville, No. 880, the coal has been opened and is reported 3 feet thick, and a short distance northeast is another old opening, No. 882. About 1½ miles northeast of Eddyville, near the quadrangle margin, No. 883, is a working bank at which the coal has the following section:

Lower Kittanning coal northeast of Eddyville, No. 883 (Pl. VI, 36).

	Ft.	in.
Coal		6
Parting		
Coal	1	6
Parting		
Coal		8
Parting		
Coal		8
	3	4

Near by, No. 884, is an old opening. East of Charlestown, near the margin of the Rural Valley quadrangle, No. 885, the blossom of the coal shows in the road and indicates a thickness of 1 to 2 feet, and west of Charlestown is an old opening, No. 886. Toward the head of Little Mudlick Creek the blossom of the coal shows at a number of points, Nos. 887 to 889; still higher is an opening, No. 890, at which the coal is 2 feet thick, and just above is another old opening, No. 891. On the whole this coal seems to be variable and of uncertain value across the central part of this basin from Putneyville to Dee, but of greater thickness and value to the east from Charlestown to Belknap.

MIDDLE KITTANNING COAL.

Very few indications of the Middle Kittanning coal were noted in the Mahoning basin. It makes a good showing in the road on the point of the spur south of Mahoning Furnace, No. 892, and is reported to have been opened and found 3 feet thick in the vicinity. On the ridge southwest of Eddyville, No 893, is an old opening in this coal and just south, No. 894, its blossom was seen in the road.

UPPER KITTANNING COAL.

In the upper portion of this basin the Upper Kittanning seam is locally of great thickness. It is also present between Widnoon and Kellersburg, but nothing definite was learned about it in that locality. About 1 mile east of Widnoon is an old pit, No. 895, that appears to be in this seam. Southwest of Deanville, No. 896, it was seen in a ravine below 10 feet of flaggy sandstone and it outcrops in the road near by. At both points it appeared to have a thickness of 2 feet. Below the road southwest of Goheenville, No. 897, is an old opening probably in this coal. On the hill 1 mile south of Eddyville is an old opening, No. 898, at which this coal is reported 3 feet thick. It is best developed, however, in the ravine of Cathcart Run north of Putneyville and on the east side of Little Mudlick Creek. At the former place the seam reaches a thickness of 15 feet in the Brooks bank, No. 899, and is composed of two benches of cannel coal or shale and two of bituminous coal, as shown in the section below:

Upper Kittanning coal at Brooks bank, No. 899, near the head of Cathcart Run north of Putneyville [a] *(Pl. VII, 57).*

	Ft.	in.
Cannel shale	5	1
Bituminous coal	1	
Cannel	{ to 7	10
Bituminous coal	2	
	{ 8 to 15	11 1

An analysis of the cannel shale at this bank is given in No. 11 of the table on page 98. On the east side of Little Mudlick Creek the coal is of better quality than elsewhere and it has been worked for years at the Thompson and Wynkoop banks, in which the seam has the section given below:

Upper Kittanning coal at Thompson bank in Little Mudlick Creek [a] *(Pl. VII, 58).*

	Ft.	in.
Slate roof		
Bituminous coal	4	
Cannel	{ to 8	0
Bituminous coal	1	11
	{ 5 to 13	11 11

See analyses Nos. 12, 13, and 14 (p. 98).

[a] Platt, W. G., Second Geol. Survey Pennsylvania, Rept. H5, p. 178.

Upper Kittanning coal at Wynkoop bank, Little Mudlick Creek[a] *(Pl. VII, 59.)*

	Ft.	in.
Slate roof.		
Bituminous coal	2	2
Cannel coal	1 to 6	
Bituminous coal	to 1	6
	4	8
	to 9	2

The exact location of these banks is not known to the writer, but there is a bank, No. 900, on the east side of Little Mudlick Creek about 2 miles below where it crosses the quadrangle boundary, that may be one of them. At any rate the bank is in the general locality in which this seam reaches the good development shown in the sections.

East of Charlestown, and probably off the quadrangle, this seam is found to thicken up again over a small area. It has been worked at a bank on the Jacob Schieck farm where the section is similar to those given above.[b]

Platt, writing twenty-five years ago, stated that this seam had not been found on the west side of Pine Run in the vicinity of Charlestown and McWilliams, though diligent search had been made by the farmers of that locality, nor had it been found on the west side of Little Mudlick Creek. The present writer found nothing indicating any recent discovery of the coal in these areas.

It seems likely, therefore, that the seam as developed at the Brooks, Thompson, and Wynkoop banks is of small extent, not persisting through the hill from the Brooks bank to the west side of Little Mudlick Creek, nor from the Thompson and Wynkoop banks to the valley of Pine Run on the east. Whether the seam extends from the region of the Bostonia mine near New Bethlehem to that of the Brooks bank with anything like the thickness existing at those places is unknown, but the presumption is against such a conclusion. As will be shown later (p. 94) the greatest thickness at Bostonia in the Redbank basin south of New Bethlehem persists only along the main heading, while on the cross headings it thins out rapidly. Platt describes the thick coal on the east side of Little Mudlick Creek as lying in a series of troughs running in a northeast-southwest direction and thinning on each side in the transverse direction, a feature that is well shown in the Thompson bank, where the main entry is driven in a southeast direction across the troughs and the intervening rolls. At the mouth of the entry the cannel is only a few feet thick, while at a distance of 100 feet from the pit mouth it thickens to 8 feet and the floor of the seam descends a corresponding amount. From this point the floor rises along the main entry, the cannel thins gradually and finally disappears, leaving only the two bituminous benches which have united at the level of the top of the seam. In the center of this depression side headings have been driven off from 50 to 100 feet, but no thinning of the cannel occurred. In other workings in this vicinity the bituminous bench has been worked across the comparatively narrow ridge and into the next adjoining trough on the southeast.

It thus appears that in these limited areas of special thickening the increase in thickness is due to the development of a lenticular bed of cannel which lies above a bench of bituminous coal or is intercalated between two benches of the same. In all cases the roof of the seam is said to form a nearly regular surface, while the increased thickness of the seam where the lenses of cannel are present is accommodated by depressions in the floor of the seam.

As shown above, the lateral extent of these troughs is comparatively limited; their longitudinal extent, so far as the writer is aware, has in no case been determined. Nor is it known whether there may not be other deposits of a similar nature in this region that do not crop out and have never been discovered. These matters could only be determined by diamond drilling or by following out the seam under the surface.

[a] Platt, W. G., Second Geol. Survey Pennsylvania, Rept. H5, p. 178.
[b] Platt, op. cit., p. 182.

LOWER FREEPORT COAL.

Generally the Lower Freeport is not an important coal in this basin. It was mined below the coke yards at Mahoning Furnace, No. 901, and Platt [a] measured the following section there:

Lower Freeport coal at Mahoning Furnace, No. 901 (Pl. VIII, 73).

	Ft.	in.
Coal	2	
Slate		2
Coal	1	8
	3	10

See analysis No. 18 (p. 98) for the composition of the coal at this point.

Platt states that the coal is so loaded with pyrites as to be worthless, and mining was abandoned. North of this point, near Oakland, No. 902, the coal shows in the road and is about 2 feet thick. In a ravine about 2 miles southeast of Mahoning Furnace, No. 903, about 3 feet of the seam is exposed, and it is reported 5 feet thick. About one-half mile northwest of this point the coal yields a large blossom in the road, No. 904. On the point of the sharp spur south of Mahoning Furnace, No. 905, it has been worked and is reported from 4 to 5 feet thick. In the John Brosius well No. 2 (397), northwest of Gohcenville, the Lower Freeport coal is reported 5 feet thick at a depth of 94 feet, and in the Brosius well No. 1 (398) it is 4 feet thick at a depth of 90 feet.

About 1 mile east of Gohcenville the coal has been opened near the road, No. 854. One-half mile northwest of Belknap the coal makes a good showing in the road, No. 907, as it also does at points farther northwest, Nos. 908 and 909. On the Smullen farm, which from description appears to be near the head of Cathcart Run, the coal was found 3 feet 1 inch thick in a diamond-drill hole. About 1 mile west of the mouth of Little Mudlick Creek, No. 910, this coal shows in the road, and near by it was reported 3 feet 5 inches thick in a diamond-drill hole. It shows again in the road west of Little Mudlick Creek, No. 911. On the high knob in the northeast corner of the quadrangle is an old opening, No. 912. East of Little Mudlick Creek it shows in the road over the ridge to Charlestown, No. 913, and is from 1 to 2 feet thick. Just across the ridge to the east, No. 914, it also shows and along the ridge to the northeast on the little knob by the roadside, Nos. 915 and 916, fragments of coal were seen that probably came from this seam.

While this coal may be locally of considerable thickness in certain parts of the basin, it would appear from the foregoing description that it is very irregular and generally too thin to be of value.

UPPER FREEPORT COAL.

The Upper Freeport coal is the most important coal of the basin. Although it has been eroded from large portions of the area crossed by the Kellersburg anticline on the west and by the Greendale anticline on the east, it underlies large tracts along the axis of the Fairmount syncline and outliers of considerable size flanking the syncline on both sides. This coal was formerly mined to a considerable extent in a ravine about 1 mile southeast of Dee, No. 917, and coked for use at Stewardson Furnace, which was located at Dee. (See analysis No. 23, p. 98.) In the next ravine to the south of Scrubgrass Creek is a working bank, No. 918, and on the spur to the north is an old pit, No. 919. On the Robert Thompson property, south of Scrubgrass Creek, 1½ miles above its mouth, No. 920, is an old stripping at which coal is reported 3 feet thick and of good quality, and one-half mile to the east is the Austin bank, No. 921, at which the coal is 3 feet thick (Pl. IX, 132).

Three-quarters of a mile east of the Austin bank is an old opening, No. 922; on the north side of the creek opposite the Austin bank, No. 923, is another, and 1½ miles to the east is the Kuhns bank, No. 924, at which the coal is 3 feet 4½ inches thick (Pl. IX, 133). In the J. M. Halderman well (396), just to the east of the Kuhns bank, the coal is reported 3 feet thick and 40 feet deep.

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 160.

South and southeast of Goheenville are four banks, Nos. 925 to 928; at No. 928 the thickness is 3 feet 2½ inches (Pl. IX, 134). East of Goheenville is an old opening, No. 929, a bank, No. 930, at which the coal is 3 feet 6 inches thick, and the Peter Kammerdiener bank, No. 931, at which the coal is 3 feet 8 inches thick (Pl. IX, 135). One-half mile northwest of the Kammerdiener bank is an old bank, No. 932, and a good showing in the road, No. 933; three-fourths mile east of the Kammerdiener bank is another working bank, No. 934. On the knobs in northern Wayne Township, between Belknap and Putneyville, are working banks Nos. 935, 937, and 940, and abandoned banks, Nos. 936, 938, and 939. In this vicinity Platt [a] obtained the section below:

Upper Freeport coal on John Reeseman farm, near McCrea Furnace (Pl. IX, 136).

	Ft.	in.
Coal	2	3
Slate		1½
Coal	1	8
	4	½

There are a few small outliers of this coal on the knobs south of Kellersburg and on one is a bank, No. 941, at which the coal is 2 feet 10 inches thick (Pl. IX, 137). On the knob three-fourths mile farther south is an old opening, No. 942. On the ridge west of Deanville the coal shows in the road, No. 943; across the ridge to the east, No. 944, is an old opening, and another on a little knob just west of Deanville, No. 945. Southward from Deanville the coal shows in the road at No. 946. There is an old opening at No. 947, a blossom at No. 948, another old bank at No. 949, and a working bank, No. 950. North of Deanville is an old bank, No. 951, and about three-fourths mile farther north is Reedy's bank, No. 952, at which the following section was measured:

Upper Freeport coal at Reedy's bank, No. 952, Deanville (Pl. IX, 138).

	Ft.	in.
Bone		1½
Coal	3	2½
Parting		½
Coal	1	
	4	4½

North of Reedy's bank is an old prospect pit, No. 953, and an old bank, No. 954. Along the ridge above Redbank Creek at the point of Anthonys Bend the coal shows in the road, No. 955; a short distance east is a bank, No. 956; a little way to the south is an old opening No. 957, and at the head of the ravine one-half mile farther south is a working bank, No. 958, at which the coal is 3 feet 9 inches thick, with a few thin, irregular partings (Pl. IX, 139). On the ridge about one-half mile west of Oakland is an old pit, No. 959, at which the coal is reported 4 feet thick. Just south of Oakland are two old banks, No. 960, and about three-fourths mile south is a working bank, No. 961, at which the following section was measured:

Upper Freeport coal south of Oakland, No. 961 (Pl. IX, 140).

	Ft.	in.
Coal		9
Parting (thin).		
Coal	1	1
Parting (thin).		
Coal	1	1
Parting (thin).		
Coal		10
	3	9

One mile south of Oakland is a bank on the Doverspike farm, No. 962, and across the ridge to the east is an old opening, No. 963. Near the southern point of the ridge over-

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 146.

looking Mahoning Furnace is a working bank on the Falk farm, No. 964, at which the following section is shown:

Upper Freeport coal at the Falk bank near Mahoning Furnace, No. 964 (Pl. IX, 141).

	Ft.
Coal	3
Bony coal	1
	4

On the point of the spur to the northwest of Mahoning Furnace is the old mine, on the Colwell property, No. 965, that supplied coal for the coke used at the furnace. Platt[a] reports the coal here 3 feet 11 inches thick. His analysis of a sample of the coal from this mine is No. 25 of the table on page 98. On the road up the bluff of the Mahoning, 2½ miles southwest of Mahoning Furnace, No. 966, is a working bank at which the coal is 3 feet 5¾ inches thick, with a few thin, irregular clay seams (Pl. IX, 142). Just around the point of the hill in the next ravine to the east, No. 967, are old openings, and on the sharp spur south of Mahoning Furnace, No. 968, the coal shows in the road. Still farther east, in the northwest corner of Wayne Township, it shows in the road at No. 969, and in a ravine at No. 970 it was reported stripped at one time. Just east is an old opening, No. 971. Northeast of this point, at the head of the ravine known as Sandy Hole, No. 972, is a bank on the Smith farm, at which the coal is 3 feet 10 inches thick (Pl. IX, 143). About 1 mile southeast of the Smith bank is another, No. 973. On the knobs south of Putneyville the coal makes a good showing in the road, No. 974; a little to the north is an old bank, No. 975, and on the knob to the north of the last-named point is the Saxman bank, No. 976, in the last outlier of the coal in this direction.

On the ridge north of Mahoning Creek, about 1 mile west of Putneyville, is a bank, No. 977, and in the ravine to the north is an old opening, No. 978. Farther east in the road northwest of Putneyville, No. 979, the coal shows below the Mahoning sandstone, which is here 40 feet thick. On the point one-half mile northwest of Putneyville is the Putney bank, No. 980, at which the coal is 3 feet 5 inches thick (Pl. IX, 144).

About 1 mile north of Putneyville is a bank, No. 981, at which the coal is 3 feet 9 inches thick, with sporadic partings of clay of little importance. At the head of the ravine to the north, No. 982, is an opening, probably into the Fairmount No. 4 mine. West of Little Mudlick Creek, No. 983, the blossom of the coal was seen. About 3 miles farther northeast, No. 984, the blossom was seen at two points, and there is a bank near by, No. 985. The seam just catches in the top of the high hill in the northeast corner of the quadrangle and has been opened within 30 feet of the top, No. 986. Along the ridge between Little Mudlick Creek and Pine Run the coal was noted at several points, Nos. 987 to 991. Beginning about 1 mile north of Mahoning Creek and proceeding northward these observations were as follows: At No. 987 is an old opening, at No. 988 a working bank, at No. 989 is another old opening, at No. 990 is an outcrop indicating a good thickness, and at No. 991 are fragments and the coal was reported present.

COALS IN THE REDBANK BASIN.

POCONO COAL.

The whole series of coals from the Pocono up is represented in this basin. The underclay of a Pocono coal is opened at the mouth of Rock Run, No. 992, and the coal is represented by the overlying black shale. Just north of the quadrangle and west of Leatherwood station two thin seams of impure coal of Pocono age are exposed in a railroad cut.

MERCER COAL.

What is probably the Mercer coal shows just above the railroad crossing south of Lawsonham, No. 993, where it is in two benches, separated by fire clay, the upper of which is 6 inches and the lower 2 inches thick. At the clay pits south of Climax, No. 994, the coal is 1 foot 6 inches thick. It is nowhere known to be of value in the region.

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 160.

BROOKVILLE COAL.

The blossom of the Brookville coal was noted south of Redbank Creek, near Shannon, No. 995. It is partially exposed in the road about midway between Widnoon and Lawsonham, No. 996, as a coal or coaly shale 1 to 2 feet thick, and its blossom was seen in the road one-half mile farther north, No. 997. It is not known to be of workable thickness in the basin.

CLARION COAL.

The Clarion coal was noted as a 6-inch layer in a shale cut by the road three-fourths mile south of New Bethlehem, No. 998. It is not known to be of value in the basin.

LOWER KITTANNING COAL.

The Lower Kittanning coal is a very valuable bed in the lower part of the basin. Openings were seen at several points north of the creek in the Kittanning quadrangle, Nos. 999 to 1001, and south of the creek 1 mile south of Shannon is a working bank, No. 1002. At Cingler's bank, in a ravine about 1 mile northwest of Widnoon, No. 1003, this seam is 4 feet thick (Pl. VI, 37). By the road, 1½ miles north of Widnoon is a bank, No. 1004, and across the ridge to the west is an old opening, No. 1005. South of Redbank Creek, east of Lawsonham, is an old opening, No. 1006, and a bank on the Duncan property, No. 1007, at which the coal is 4 feet 1 inch to 4 feet 6 inches thick (Pl. VI, 38). North of Redbank Creek, east of Lawsonham, are old openings, Nos. 1008 to 1010. In a ravine 1½ miles west of Kellersburg is a bank on the Maginnis property, No. 1011, at which the coal is 3 feet 9 inches thick (Pl. VI, 39). In the Maginnis well (408) this coal is reported 4 feet thick and 85 feet deep, and in the D. O. Collen well (407) near by it is reported 5 feet thick and 185 feet deep. Within 1½ miles north of Kellersburg the coal is known at a number of points as follows: At Nos. 1012 to 1014 are banks; at No. 1015 is a blossom; at No. 1016 is a bank at which the coal is reported generally poor, being from 1 foot 6 inches to 3 feet thick, and at No. 1017 is an old opening. This coal was next noted in the bluff overlooking the creek at Anthonys Bend, No. 1018. At this point the deterioration in the character of the Lower Kittanning seam, beginning in the vicinity of Kellersburg, has apparently reached its culmination, as is shown by the following section:

Lower Kittanning coal at Anthonys Bend (No. 1018), (Pl. VI, 40).

	Ft.	in.
Coal		1
Shale		3
Coal		10
Shale		2
Clay		4
Coal		3
Shale		1
	2	

East of the narrows at Climax there are old openings, Nos. 1019 and 1020. Nothing was seen of this seam between this point and the Fairmount No. 5 mine, east of New Bethlehem, near the quadrangle boundary, No. 1021. At this mine the coal shows a return to its normal thickness in the Allegheny Valley and is 3 feet 1 inch thick (Pl. VI, 41). The Lower Kittanning coal has been extensively mined immediately north of the quadrangle in this locality and is known by the fanciful name of the Fishbasket vein. Just north of the quadrangle, in the ravine 2 miles east of the west boundary of Redbank Township, the coal was noted and appears to be about 2 feet thick.

MIDDLE KITTANNING COAL.

The middle Kittanning coal was noted only north of the creek, west of Lawsonham, in the Kittanning quadrangle, where there is an old pit, No. 1022.

UPPER KITTANNING COAL.

The Upper Kittanning coal is present over a large area along the Kellersburg anticline in the northwest corner of the Rural Valley quadrangle. It does not appear to be of minable thickness, however, though it may be so in limited areas. At Widnoon, No. 1023, its blossom was noted, and it was reported to have been struck in digging the cellar of a house, and to be 1 foot 6 inches thick. It shows in the road 1 mile to the north, No. 1024, and is apparently 1 foot thick. Its blossom was noted along the road south from Widnoon, No. 1025, and in the road about 1 mile to the northeast, No. 1026. It reaches dimensions of importance, however, only farther east. In the road near Anthonys Bend on the southwest, No. 1027, is an old bank, and farther east, presumably somewhere east of the narrows, was the Anthony mine, of which Platt[a] published the following section:

Upper Kittanning coal at the Anthony mine, east of the narrows, Mahoning Township (Pl. VII, 60).

	Ft.	in.
Cannel slate		6
Soft slate and bony coal		4
Coal	3	6
	4	4

At the Bostonia mine, 2 miles south of New Bethlehem, in Mahoning Township, an effort was once made to mine this seam on a commercial scale, but the effort was a failure. This mine was located somewhere in the vicinity indicated by No. 1028. Franklin Platt[b] published the following section of the coal at this mine, which he identified as the Lower Freeport:

Upper Kittanning coal at the Bostonia mine, south of New Bethlehem (Pl. VII, 61).

	Feet.
Cannel slate	
Cannel coal	8
Bituminous coal	2
	10

He describes the cannel bench as holding its thickness along the main entry, but thinning to nothing along the cross headings, so that beyond the limits of the cannel bench the seam consists only of the 2-foot bituminous bench. Platt[b] published analyses by McCreath of samples of the different benches of coal at this mine, which are given in the table on page 98. (See analyses Nos. 8, 9, and 10.)

Platt[c] expressed doubt whether the cannel of this region, including the localities on Cathcart Run and Little Mudlick Creek, hitherto described, is to be regarded as a true cannel coal, and called it a cannel slate with a conchoidal fracture. In addition to the conchoidal fracture it is without luster. It thus possesses the physical characters by which cannel coal is usually defined. Further, that it is a coal and not a slate is conclusively shown by the following analyses:

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 198.
[b] Second Geol. Survey Pennsylvania, Rept. H, p. 240.
[c] Second Geol. Survey Pennsylvania, Rept. H5, p. 179.

Analyses of cannel coal.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Fixed carbon	27.00	53.132	52.306	46.194	52.757
Volatile hydrocarbon	59.60	37.830	32.665	30.490	37.930
Moisture	1.30	1.610	.640	.510	1.120
Ash	12.10	6.750	13.345	22.230	6.705

1. Breckenridge cannel of Kentucky.
2. Cannel bench at the Thompson bank.
3. Upper cannel bench at the Brooks bank.
4. Upper cannel bench of the Bostonia mine.
5. Upper bituminous bench of the Thompson bank (see section, p. 88).

Analysis No. 4 is of a sample of what is probably the poorest grade of cannel of the region under discussion, yet it contains over 76 per cent of combustible matter, while the cannel from the Brooks bank contains over 85 per cent, and that from the Thompson bank over 91 per cent of combustible matter, so that it is certainly inadmissible to call any of this cannel a slate. It is a coal which in some places contains an unusually high percentage of ash. In the cannel from the Brooks bank, however, the percentage of ash is but little greater than in the Breckenridge cannel coal of Kentucky, which may be taken as a typical cannel, while the cannel from the Thompson bank contains a much smaller proportion of ash than the Breckenridge coal. So far as content of ash is concerned, then, most of the Upper Kittanning cannel in this region differs little from well-recognized cannel coals of other regions, assuming, of course, that the above analyses fairly represent its character. There is, however, one marked difference between this cannel and a typical cannel, and that is in the relative proportions of fixed carbon and volatile hydrocarbons. Nearly all coals with the physical qualities of cannel contain 45 per cent or more of volatile hydrocarbons and a smaller amount of fixed carbon. In the Breckenridge cannel the volatile matter is more than twice that of the fixed carbon. In the cannel of this region, on the contrary, the fixed carbon runs about one and one-half times the amount of volatile matter. In this respect, therefore, the cannel coal in question is not entitled to the name. It differs in no way from the upper bituminous bench of the Thompson bank, the composition of which is shown in analysis No. 5, above. In fact, except for its high percentage of ash in some cases, it is almost identical in character with most of the bituminous coal from the other seams of the region, as may be seen by a study of the analyses given in the table on page 98. It might be best described by saying that it is a coal with the physical characters of cannel and the chemical composition of a more or less impure bituminous coal of the ordinary type of the region. Judging from the analyses of this coal there appears to be no reason why it would not make a good fuel for local use, where the disposal of the ash is not a factor to be considered. It could not serve the ordinary purposes of a cannel coal. It is too poor in hydrocarbons to use in the manufacture or enrichment of illuminating gas or for the distillation of oil, and probably it does not burn so freely in an open grate as cannel coal. Furthermore, on account of its high percentage of ash it would not command as high a price in the market as the purer coals, with which it would have to compete, and there is therefore no probability of its being mined on a commercial scale so long as the better coals of the region are unexhausted. It will doubtless continue to be for some time a source of local supply for domestic use.

LOWER FREEPORT COAL.

The Lower Freeport coal is of importance only in the upper part of Redbank basin, where it has considerable extent as a workable bed. It is, however, subject to great variations in thickness within rather narrow limits. In the road south of Anthonys Bend, No. 1029, it shows a thickness of 2 feet. East of New Bethlehem, near the margin of the quadrangle, is the Fairmount No. 3 mine in this coal, and a little farther east is the Fairmount

No. 2 mine, with the opening just north of the quadrangle. At the latter mine the coal is 3½ to 4 feet thick, but very badly cut up by clay veins. In this region the interval between the Upper and Lower Freeport coals is 40 feet. No. 18 of the table (p. 98) is an analysis by McCreath of a sample of this coal from the neighboring Bostonia mine, probably near that in the Upper Kittanning seam, No. 1028. At the Oak Ridge No. 2 mine, in the western part of Redbank Township, about 1 mile south of the north boundary of the quadrangle, a thickness of 4 feet 6 inches was measured (Pl. VIII, 74). This is an exceptional thickness, and the seam is reported much cut out and too thin to mine at the south end of the property. East of the Oak Ridge mine this coal has been opened on the Kunselman property, No. 1030.

UPPER FREEPORT COAL.

The Upper Freeport coal has been eroded from the region west of Oakland. Just north of Oakland are two banks, Nos. 1031, 1032. About 1 mile northeast of Oakland is a new opening of the Fairmount Mining Company, No. 1033, at which the coal is 4 feet thick (Pl. IX, 145).

The Redbank Mining Company, which operated in this locality many years ago, worked the Upper Freeport, as well as the Lower Freeport and Upper Kittaning seams. Their mine was known as the Bostonia. Platt [a] published the following section of the Upper Freeport at this mine:

Upper Freeport coal at Redbank Mining Company's mine, Bostonia (Pl. IX, 146).

	Ft.	in.
Bony coal		6
Slate		3½
Coal	3	8
	4	5½

(See analysis No. 24, p. 98, for the composition of the coal at this mine.)

About one mile south of New Bethlehem is an opening of the Fairmount No. 4 mine, No. 1034, and just south of town is an old bank, No. 1035. The seam here is seriously affected with "rock faults," which have been encountered throughout the extent of operation, covering an area of at least 2 square miles. The coal has the usual maximum thickness of 4 feet, but it does not hold this thickness far in any direction. In a few feet or rods it thins to a few inches or disappears entirely, its place being taken by the shale of the roof. This peculiarity is illustrated by figs. 7 to 10 below.

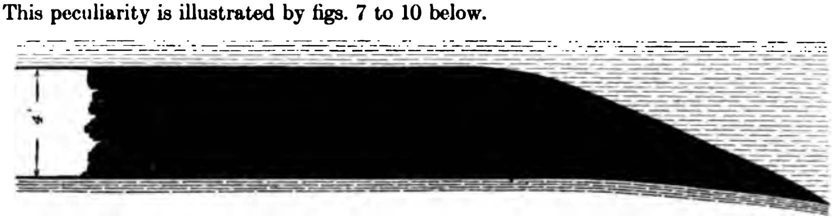


FIG. 7.—Section along main heading of Fairmount No. 4 mine, to show thinning and disappearance of coal.

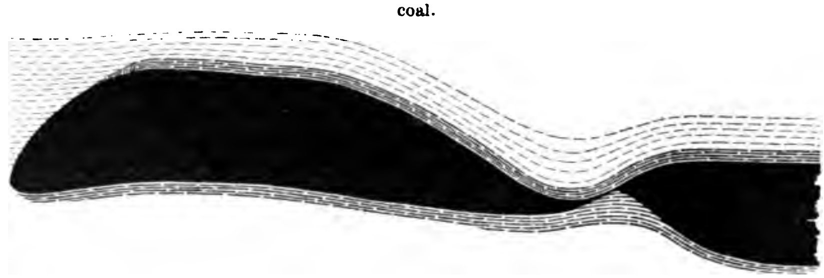


FIG. 8.—Section along main heading of Fairmount No. 4 mine, to show variations of coal and its relations to clay and shale.

[a] Second Geol. Survey Pennsylvania, Rept. H5, p. 182.

FIG. 9.

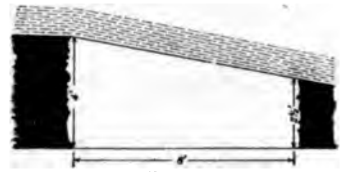


FIG. 10.

FIG. 9.—Section along main heading of Fairmount No. 4 mine, to show thinning and absence of clay.
FIG. 10.—Section across main heading of Fairmount No. 4 mine, to show rapid thinning.

In a short distance the coal reappears at the lower level of the seam and rapidly regains its full thickness. At other points the coal terminates abruptly, as shown in fig. 11. These changes are repeated over and over in all directions so that the seam is composed of irregular deposits of coal alternating in the horizontal direction. It seems probable that the vegetal matter of the coal accumulated in irregular areas of small size which were surrounded by water in which clay was simultaneously being deposited, for there are evidences along the lateral contact of the shale with the coal of an interfingering of the two substances, as if both were accumulating at the same time. This interfingering is shown in figs. 12 and 13.

FIG. 11.—Section along main heading of Fairmount No. 4 mine, to show abrupt ending of coal.

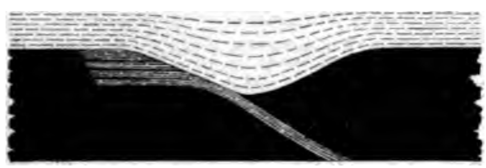


FIG. 12.

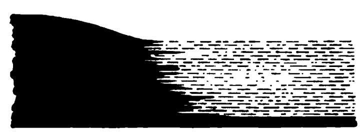


FIG. 13.

FIG. 12.—Section along main heading of Fairmount No. 4 mine, to show interfingering of coal and clay and relations of coal, clay, and shale.
FIG. 13.—Section along main heading of Fairmount No. 4 mine, to show interfingering of coal and shale.

The only other explanation that seems at all probable is that the vegetal matter accumulated uniformly over the whole area and was subsequently eroded by currents of water in the places now occupied by shale, but it is difficult to conceive how erosion could have produced such irregularities as exist over so large an area. The form and arrangement of the shale deposits replacing the coal certainly do not suggest such an origin. At any rate it is evident that the present condition of the coal seam in this locality is due to accidents of its original accumulation and not to any subsequent upheaval of the rocks or to volcanic action, as some have supposed. On account of this supposition operations have been pushed southward in the hope of reaching improved conditions in the coal to the south of a ravine cutting the property. It is of course quite possible that better conditions may exist south of the ravine, but it is evident that there is no possible connection between the character of the coal seam and any features of surface relief. These features came into existence ages after the character of the coal seam was fixed.

East of the Fairmount mines are those of the Oak Ridge Mining Company. Oak Ridge Nos. 3 and 5 mines are working this seam. At the latter mine the Upper Freeport coal is 3 feet 5 inches thick (Pl. IX, 147). South of these mines is an opening, No. 1036, probably of one of the Fairmount mines. On the Kunselman property to the east of the Oak Ridge mines is an old opening, No. 1037.

Analyses of coals in the Kittanning

No.	Name of seam.	Locality.	Owner.	Analyst.
1	Clarion	West Winfield	A. G. Morris	E. C. Sullivan, U. S. G. S. [a]
2	Lower Kittanning.	Mahoning	Mahoning Coal Co	A. S. McCreath (H5, p. 232).
3	....do	Rogers farm, west of Buffalo Mills, near county line.		A. S. McCreath (H5, p. 287).
4	....do	Kittanning	Kittanning Clay Mfg. Co.	Geo. Steiger, U. S. G. S. [a]
5	....do	Mouth of Cowanshannock Creek.		....do. [a]
6	....do	Craigsville	Mr. Bowser	....do. [a]
7	....do	¾ mile east of Greendale.	Rhea farm	A. S. McCreath
8	Upper Kittanning.	Bostonia, south of New Bethlehem.	Redbank Mining Co., cannel bench, analysis No. 1.	A. S. McCreath (H., p. 240).
9	....do	....do	Redbank Mining Co., cannel bench, analysis No. 2.	....do
10	....do	....do	Redbank Mining Co., bituminous bench.	....do
11	....do	Cathcart Run	Brooks bank	A. S. McCreath (H5, p. 180).
12	....do	Little Mudlick Creek	Thompson bank, upper bench, bituminous.	....do
13	....do	....do	Thompson bank, middle bench, cannel.	....do
14	....do	....do	Thompson bank, lower bench, bituminous.	....do
15	....do	Pine Furnace		A. S. McCreath (H5, p. 123).
16	....do	Yatesboro	B. Schreckengost	A. S. McCreath (H5, p. 94).
17	Lower Freeport	Cowansville	Cowansville Mining Co.	W. F. Schaller, U. S. G. S. [a]
18	....do	Mahoning Furnace		A. S. McCreath (H5, p. 161).
19	....do	Bostonia	Redbank Coal Co	A. S. McCreath (H5, p. 192).
20	Upper Freeport	Near Freeport, off quadrangle.		A. S. McCreath (H5, p. 262).
21	....do	1¼ miles southwest of North Buffalo post-office.	Bruner bank	Geo. Steiger, U. S. G. S. [a]
22	....do	1 mile east of Ewing	Galbreath bank	....do
23	....do	Stewardson Furnace (Dee).		A. S. McCreath (H5, p. 171).
24	....do	Bostonia	Redbank Coal Co	A. S. McCreath (H5, p. 193).
25	....do	Mahoning Furnace	Colwell's mine	A. S. McCreath (H5, p. 160).
26	....do	Mosgrove	Pittsburg Plate Glass Co.	
27	....do	Yatesboro	Patterson mine	A. S. McCreath (H5, p. 91).
28	....do	Blanco	Beers bank	A. S. McCreath (H5, p. 92).

[a] Collected by J. S. Burrows.

NOTE. H and H5 in "Analyst" column refer to reports of the Second Geological Survey of Pennsylvania.

and Rural Valley quadrangles.

Fixed carbon.	Volatile combustible.	Moisture.	Ash.	Sulphur.	Phosphorus.	Total.	Color of ash.	Coke (per cent).	Character of coke.	Fuel ratio.
50.83	36.19	2.20	10.78	[b] 3.35	....	100.00	Slightly red.	....	Swollen, porous.	1:1.44
49.686	42.560	1.180	4.585	1.999	.0061	100.0061	Pinkish gray.	56.270	....	1:1.17
48.747	42.720	1.160	5.065	2.313	....	100.00	Reddish gray.	56.120	....	1:1.14
53.59	35.09	1.61	9.71	[b] 4.62	....	100.00	....	....	....	1:1.52
49.19	32.93	3.19	14.69	[b] 7.32	....	100.00	....	....	....	1:1.49
52.97	37.06	1.89	8.08	[b] 4.41	....	100.00	....	....	....	1:1.42
52.032	38.205	.906	5.140	3.663	....	100.00	Reddish gray.	60.835	....	1:1.36
46.194	30.490	.510	22.230	.576	....	100.00	....	....	Poor....	1:1.51
49.815	31.680	.730	17.320	.435	....	100.980	....	....	....do...	1:1.54
52.716	39.120	1.650	3.880	2.634	....	100.00	Brown..	59.23	....	1:1.34
52.306	32.665	.640	13.345	1.044	....	100.00	Gray....	66.695	....	1:1.60
52.575	37.930	1.120	6.705	1.388	....	100.00	Reddish gray.	60.850	....	1:1.39
53.132	37.830	1.610	6.750	.678	....	100.00	Gray....	60.560	....	1:1.40
54.482	34.465	.810	9.655	.588	....	100.00	....do...	64.725	....	1:1.58
58.301	34.185	1.820	4.705	.989	....	100.00	Cream..	63.995	....	1:1.70
53.224	34.270	.910	9.285	2.211	....	100.90	Gray....	....	....	1:1.55
53.34	31.73	2.97	11.96	[b] 3.51	....	100.00	....	....	Good...	1:1.62
50.265	37.110	1.070	8.330	3.225	.0092	100.0992	Pinkish gray.	61.820	....	1:1.35
53.960	35.940	1.690	5.040	3.380	....	100.00	Gray....	62.370	....	1:1.50
50.206	39.835	1.430	5.710	2.819	....	100.00	Cream..	58.735	....	1:1.26
51.37	29.00	2.17	17.46	[b] 2.58	....	100.00	....	....	....	1:1.77
49.78	31.65	2.72	15.85	[b] 4.06	....	100.00	....	....	....	1:1.57
55.545	35.520	1.470	6.630	.835	.0684	100.00	Yellowish gray.	63.010	....	1:1.56
53.661	35.940	1.840	6.820	1.739	....	100.00	Gray....	62.220	....	1:1.49
54.996	34.810	1.450	7.690	1.054	....	100.00	....do...	63.740	Tender .	1:1.58
51.13	34.22	2.30	10.70	1.65	....	100.00	....	....	....	1:1.48
53.569	36.995	1.020	5.775	2.461	....	99.820	Cream..	61.981	....	1:1.45
57.179	37.860	1.140	2.790	1.031	....	100.00	....do...	61.000	....	1:1.51

[b] Sulphur separately determined.

ANALYSES OF COALS.

In the foregoing tables, pages 98, 99, are a number of analyses of samples from the various coal seams of the quadrangles. With two exceptions these samples were collected in the quadrangles. Several of the analyses were made by A. S. McCreath, of the Second Geological Survey of Pennsylvania, and published in Report H5 on Armstrong County. The remainder were made by various chemists of the United States Geological Survey. These latter analyses present considerable differences from those made by McCreath. They are higher in fixed carbon and much higher in ash and sulphur. On the other hand they run much lower in volatile hydrocarbons. The fuel ratio is also much higher. These differences may be accounted for in part on the assumption that the two sets of samples were selected differently. The samples collected in the present survey were taken by cutting a section from the face of the seam about 1 inch deep and 2 inches wide, then thoroughly pulverizing this, dividing it into quarters, and rejecting opposite quarters. This process was repeated until the sample was reduced to a convenient quantity. In taking the samples such partings were rejected as are rejected in mining, so that they fairly represent the character of the seam. It seems not improbable that the specimens analyzed by McCreath were selected after the coal was mined, and therefore do not so fairly represent the seam as a whole. If this assumption is correct, it would explain the differences in the proportions of ash and sulphur.

ACREAGE AND AMOUNT OF UPPER FREEPORT AND LOWER KITTANNING SEAMS.

In the Kittanning quadrangle the total area underlain by the Upper Freeport coal is about 69,000 acres and in the Rural Valley quadrangle about 66,000 acres, making a total of 135,000 acres. In the former quadrangle the area of Lower Kittanning coal is 123,000 acres, and in the latter it is 117,000 acres, making a total of 240,000 acres.

In the Kittanning quadrangle the Upper Freeport coal is known to be too thin to mine in some localities, as appears from the details already given. It is not believed however, that the total area of such localities is large. It may amount to 10 per cent of the whole, or approximately 7,000 acres. Deducting that from the total leaves 62,000 acres of minable coal. In the Rural Valley quadrangle the whole area of Upper Freeport coal is minable, so far as known. This would make the total area of minable Upper Freeport coal in the two quadrangles 128,000 acres. According to reports from the various mines in the region, this seam yields 3,500 to 5,500 tons of run-of-mine coal to the acre, with an average in 5 mines reporting of 4,330 tons per acre. Accepting 4,000 tons per acre as a conservative estimate of the yield per acre of this seam in the quadrangles and the acreage as 128,000, as estimated above, the total minable coal in the Upper Freeport seam in the quadrangles would be 512,000,000 tons of run-of-mine coal.

In the case of the Lower Kittanning coal the territory of the quadrangles may be divided into two parts by a line drawn from Kellersburg southwest through Kittanning. West of this line all observations point to the fact that this seam is everywhere minable. This territory embraces the 123,000 acres of Lower Kittanning coal in the Kittanning quadrangle and nearly 11,000 acres of its area in the Rural Valley quadrangle, making 134,000 acres in all. The mines working the seam in this area report an average yield of 4,833 tons of run-of-mine coal to the acre. Allowing 4,500 tons as a moderate estimate, the total minable Lower Kittanning coal in this area would be 603,000,000 tons of run-of-mine coal. East of the line described above the value of the Lower Kittanning coal is more problematical, as is shown in the foregoing descriptions of the coals. According to all observations, however, the seam rarely falls below 2 feet in thickness and over a considerable part of the region it is known to be 3 feet thick, or over. Taking into consideration all actual observations in connection with such scattering and more or less unreliable measurements of the coal as are given in deep-well records, it is a fair estimate that the seam will average 2 feet 6 inches of minable coal over the area of 106,000 acres remaining after deducting the 11,000 acres mentioned above. Actual reports would indicate that each foot in thickness of this coal will yield something over 1,000 tons per acre.

Taking 1,000 tons, however, as a safe estimate, the territory under consideration will

yield 2,500 tons per acre. That would give 265,000,000 tons available coal in the Lower Kittanning seam in the Rural Valley quadrangle east of the line described above. This makes a total of 868,000,000 tons of Lower Kittanning coal in the quadrangles and a grand total of 1,380,000,000 tons in the two seams under consideration. To this must be added the coal available in the other seams. With the exception of certain areas of Lower Freeport coal, these seams are so inconstant in thickness that reliable estimates of the amount that they contain can not be made. The foregoing description and the map will, it is hoped, assist prospectors and others interested in estimating the coal resources of special areas to reach a fairly accurate conclusion as to their value. The figures given above include the coal actually recoverable by the mining methods now in vogue.

DEVELOPMENT.

Comparatively very little of the coal of these quadrangles has been taken out. Mining operations on a commercial scale have until recent years been confined to the river region from Mahoning northward, where the Lower Kittanning has been worked. A considerable quantity of coal was taken out for coking at several points during the days when iron smelting was an industry of the region. These operations were confined largely to the Upper Freeport coal at East Brady, Mahoning Furnace, and Stewardson Furnace, and to the Upper Kittanning coal at Pine Furnace. The Upper Freeport has also been rather extensively mined at Kittanning.

At present mining operations are more active and a number of well-equipped mines are working the Upper Freeport and Lower Kittanning seams. In the vicinity of Karns the Enterprise mine is working the Upper Freeport. At Kaylor the Great Lakes Coal Mining Company has opened six mines, four in the Lower Kittanning and two in the Upper Freeport. A railroad has been built connecting with the Bessemer Railroad in Butler County, and mining on a large scale is now in progress in that locality. The Keystone, Monarch, Avondale, and Riverview mines are operating in the Lower Kittanning in the northern part of the quadrangles. The Mahoning colliery is mining the same seam at Mahoning. East of New Bethlehem are the mines of the Fairmount Mining Company and the Oak Ridge Mining Company. Both companies have well-equipped plants and are mining the Upper and Lower Freeport seams. At Cowansville is a mine in the Lower Freeport from which considerable coal is taken. At Mosgrove the Pittsburg Plate Glass Company has a large mine in the Upper Freeport. At Kittanning the Kittanning Clay Manufacturing Company is taking out a good deal of coal from the Lower Kittanning. At Yatesboro are the two mines of the Cowanshannock Coal and Coke Company; these are well-equipped plants mining the Upper Freeport coal on a large scale.

CONDITIONS OF MINING.

The conditions seem to be favorable to mining in these quadrangles. All parts are easily accessible along the side valleys of the Allegheny and the problem of transportation is a simple one. The coal seams are generally overlain by shale and underlain by clay, which are fairly easy to remove, and the shale makes a comparatively stable roof. There are, of course, areas of greater or less extent for which the above statement will not hold as to one or another seam, but on the whole it is believed to be true. The geologic structure of the quadrangles is also relatively simple, the dips are low, and at many points large bodies of coal can be taken out with but little expense for haulage. It is believed that in locating mines it will be found advantageous to consider the structure or lay of the rocks as it is delineated on the map.

DISPOSITION AND USE OF COAL.

The greater part of the coal mined in this region is shipped to New York, New England, and Canada, and used for domestic and steam purposes, for which it is reported excellent. The coal is too low in volatile matter and contains too much impurity, especially in the form of sulphur, for gas making. As before stated, coal from the Upper Freeport seam was used for coke at the Mahoning and Stewardson furnaces. It was said to make rather

tender coke, but suitable for the light burdens of the furnaces. The coke contained sufficient phosphorus to damage the iron for some purposes. At Pine Furnace the Upper Kittanning coal was coked in open pits. It is probable that by the better methods practiced at the present day the coke from the Upper Freeport coal could be much improved in quality and made to answer the purpose of smelting the native ores.

PETROLEUM AND NATURAL GAS.

HISTORICAL STATEMENT.

DEVELOPMENT OF THE PETROLEUM INDUSTRY.

As will be seen by the accompanying map (fig. 14), these quadrangles lie in the belt of oil and gas producing territory extending from southwestern New York to northern West

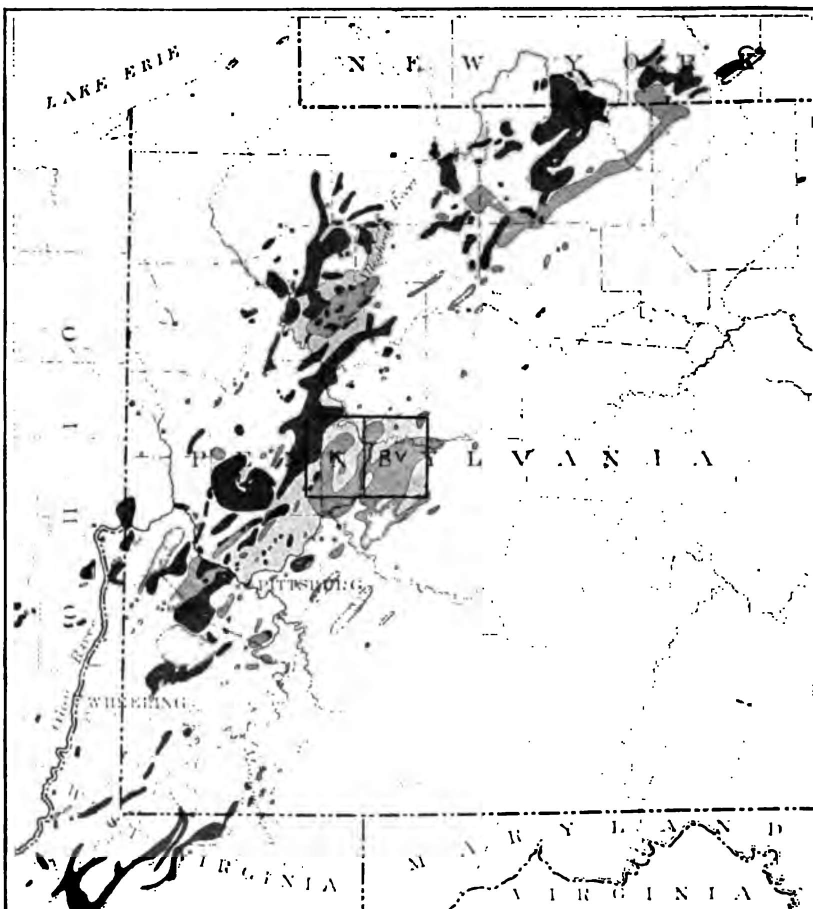


FIG. 14.—Map of the oil- and gas-bearing regions of the northern Appalachians. Light areas, gas; dark areas, oil.

Virginia. For the past thirty years petroleum has, therefore, been a most important source of wealth in the western and northwestern part of the Kittanning quadrangle. The oil producing territory is almost entirely confined to the eastern tier of townships in Butler County and to Bradys Bend Township, in Armstrong County. Outside of this territory oil has been noted in very small quantities in an occasional gas well, but so far as known

to the writer it is produced in only two wells and these are very light. They are located, one on the Rupp and the other on the Brown farm, near the southeast corner of Rayburn Township, in the Rural Valley quadrangle. The first oil wells in the Kittanning quadrangle were drilled in 1873 at Karns. Developments proceeded rapidly, and by 1875 the most productive parts of the quadrangle had been discovered and drilled over. Much of the territory was enormously productive at first, the yield of individual wells ranging from 100 to 2,000 barrels per day. One well near Chicora, though possibly not in the quadrangle, is reported to have produced 150,000 barrels of oil in nineteen months. At first the wells flowed, but as the flow decreased they were pumped, and as production diminished still further, torpedoing was resorted to in order to keep up the production. Since the early days the yield has steadily diminished, until now it is but a small part of the original amount. Many of the wells drilled at that time, however, are still pumping small quantities of oil.

Drilling has never fully ceased in the region. Additional small pools have been developed, and between the main pools many wells have been drilled which would have been unprofitable in the early days, but which, with cheaper methods of drilling and production and careful management, yield fair returns. It seems probable that there are small areas of such territory in the quadrangle still awaiting the drill and that, while the palmy days of the industry have passed, oil will long continue to be an important though constantly diminishing source of wealth in this quadrangle.

DEVELOPMENT OF THE NATURAL-GAS INDUSTRY.

Since sometime in the eighties the production of natural gas has been an important industry in the quadrangles. Gas was first encountered in drilling for oil. It was for a time allowed to go to waste, but as soon as its value for fuel and power and its suitability for use in various lines of manufacturing came to be appreciated, and methods of handling it were developed, active operations began in search of gas itself. These operations were highly successful in many localities. Large reservoirs of gas were tapped and much wealth has been derived from that source. Great activity in drilling followed the discovery of the principal reservoirs and so many wells had been sunk by 1895 that the supply from the shallow sands of the more important fields began to show signs of exhaustion. Within the last eight years much drilling has been done in all directions, with varying success, in the endeavor to maintain the supply. A good many scattering wells giving a fair yield have been struck. Some productive reservoirs of small extent have been discovered, like those at Ford City, and some of the older fields extended, like the Cowanshannock field in the direction of Muff and Belknap.

Notwithstanding all the drilling that has been done, it has been found impossible to keep up the supply and nearly all companies report a falling off. One company reports a decrease of 20 per cent in the last year. A number of wells have been drilled to the Speechley sand within the last three years and some notable strikes have been made, especially at Slate Lick and Worthington and in the vicinity of Muff. The Kerr well at Worthington, drilled in October, 1902, is a good example of the possibilities of the Speechley sand. This well started off at an estimated flow of from 22,000,000 to 30,000,000 cubic feet in twenty-four hours. One company operating in the vicinity of Muff reports that it has been able to shut in all its shallow sand wells and to supply its needs from the deeper sands. The amount produced individually by these wells is not known to the writer, but it is reported on good authority that up to June, 1903, with the exception of the Kerr well, none giving more than 1,000,000 to 2,000,000 cubic feet in twenty-four hours had ever been struck in the Speechley sand, and wells have been drilled into it in many parts of the quadrangles. Probably the larger number of wells in this sand have been complete failures. While, therefore, a big well like the Kerr, and some moderately productive wells may be found occasionally in the deeper sands, and smaller ones in the upper sands in territory that has not been thoroughly drilled, it seems improbable that any more large and highly productive reservoirs will be discovered, and thus the production of natural gas is bound to become a much less important source of wealth than it has been in the past.

GEOLOGIC OCCURRENCE OF OIL AND GAS.

In this region oil and gas occur in porous sandstone at a considerable depth below the surface. In descending order these sands are known to the driller as the Butler, Murrysville or Salt sand, Second or Hundred-foot sand, Thirty-foot sand, Third sand, Fourth sand, Fifth sand, Speechley sand, and Tiona sand.

The Murrysville and Hundred-foot sands have been the main gas producers in the past, but so many wells have been drilled into them that their production has decreased greatly and is still diminishing. A few wells have secured a good flow of gas from the Thirty-foot, and fewer still from the Fifth sand. The Fourth sand is not a gas-producing sand. Within the past few years much drilling has been done to the Speechley sand with results that have been stated above. In the vicinity of Goheenville the Tiona sand has recently attracted considerable attention and some good wells are reported in it. In a very few wells gas has been recorded in sands above the Murrysville, but generally in small quantities. So far as the writer is aware, no important supply of gas has been found in the upper sands except in the William Wadding well, in Wayne Township. This well started off with a production of about 1,000,000 cubic feet of gas in twenty-four hours from a sand about 300 feet above the Murrysville and about 600 feet below the Vanport limestone. The gas was soon exhausted.

DESCRIPTIONS OF OIL- AND GAS-BEARING ROCKS.

The oil- and gas-bearing rocks of central western Pennsylvania are deeply buried beneath the surface and their character and position are known only from the records of the numerous wells that have been drilled in search of oil and gas. In prospecting for these valuable products the Vanport (Ferriferous) limestone generally has been taken as a key stratum, and the identification of the oil and gas sands has largely depended upon their distance and sequence below this bed. The well sections on Pls. I to IV and the table of partial well records on pages 110 to 161 will be found useful for reference in reading this chapter.

MURRYSVILLE GAS SAND.

The first or uppermost member of the oil- and gas-bearing rocks is the Murrysville gas sand. In the Allegheny Valley proper this sand is generally known as the Butler gas sand, but to avoid confusion with the name Butler sandstone as applied to a member of the Allegheny formation, the name Murrysville is here used, because the first gas field in this sand was developed at Murrysville, in Westmoreland County.

In a large part of the territory the Murrysville sand is an important source of gas, but in other parts it is of much less importance than some of the underlying Venango oil sands, especially the Hundred-foot sand at the top of the group.

Depth below Vanport limestone.—The Murrysville sand was first noted as a separate and well-recognized gas-bearing stratum in some of the oil wells near the original oil pool developed in the northeast corner of Butler County. In the wells about Petrolia and Karns, this sand is probably represented by the "Thousand-foot shells." In this region the top of the sand varies from 760 to 825 feet below the Vanport limestone, and from 125 to 160 feet above the top of the Venango oil sands. North of this field it probably has no representative, or at least no sand occurs at this horizon that is at all continuous or well marked. In the southern part of the Kittanning quadrangle the interval between this sand and the Vanport limestone is 930 feet, and the interval between it and the oil sands is about 60 feet.

Assuming that the sands identified as Murrysville throughout the quadrangles are parts of a persistent stratum, a doubtful assumption, there is a gradual increase in its depth below the limestone from north to south and a gradual approach to the top of the Venango oil sands. In Allegheny Furnace No. 3 (262) and Montgomery No. 3 (298) wells, both near the boundary between the quadrangles, the Murrysville sand seems to be almost immediately on top of the Hundred-foot sand, or to be separated from it by only a few feet of shale, a condition that is of frequent occurrence in the Rural Valley quadrangle.

In 52 wells selected from various parts of the Kittanning quadrangle, the average interval between the Vanport limestone and the Murrysville sand is 862 feet, and in 45 wells in the Rural Valley quadrangle the average interval is 850 feet.

Thickness.—The thickness of the Murrysville sand varies as greatly as the intervals above described. In some wells it reaches a thickness of 100 feet. In others it is thin or broken into two benches by a bed of shale of varying thickness, and in still others it was not found at all. The mean thickness of the sand in 44 wells in the Rural Valley quadrangle is 49 feet.

Extent.—So far as available records show, the Murrysville sand can not be identified even as a gas-bearing horizon very far north of these quadrangles, although gas is occasionally noted in the rocks above the Venango sands in that region. To the south and east it persists as an important gas-producing rock at least as far as Murrysville, in Westmoreland County.

Variations.—It is much to be doubted whether the Murrysville sand as noted in the various well records is really one and the same continuous stratum. It seems highly probable that the sands occur as lenses rather than as beds of even thickness and wide distribution. Moreover, it may be doubted whether these lenses occupy the same geologic plane and are contemporaneous deposits.

The actual condition seems to be that beds of gas-bearing sandstone occur at various levels in the 200 feet of strata immediately overlying the Venango oil sands, the higher beds generally lying to the north and the lower beds to the south, and that the first of these gas-bearing sands encountered in drilling is always called the Murrysville sand.

VENANGO OIL SANDS.

As already noted, the oil in this region occurs in a well-defined group of sandstone beds, which has long been known as the "Venango oil-sand group."[a] This group of oil-bearing rocks is composed of beds of coarse sandstone alternating with bands of shale of various colors, among which red probably predominates. The sand beds rarely exceed 50 feet in thickness, and they vary in texture from fine-grained sandstone to coarse conglomerates. The characteristic features of the mass are the abundance of sand beds and the red shales with which they alternate.

The sands are known as the Second or Hundred-foot, Blue Monday, Boulder, Stray, Third, and Fourth sands. The upper members of this group are generally nonproductive, but the Stray, Third, and Fourth sands constitute the great oil reservoirs of this part of the Allegheny Valley.

Thickness and depth below the Vanport limestone.—The top of the Hundred-foot, the uppermost of the Venango oil sands, varies from 920 feet below the Vanport limestone in the northwestern part of the Kittanning quadrangle to 1,090 feet in the southern part. The former interval is shown in the Hazlewood and Evans wells near Karns, just north of the quadrangle, and the latter, which is an extreme measure, in the Rayburn well near Slate Lick. In 61 wells in the Kittanning quadrangle the mean interval is 985 feet, and in 45 wells in the Rural Valley quadrangle it is 954 feet. The bottom of the Fourth sand, which seems to be the lowest oil-producing rock, is here regarded as the bottom of the group. It varies from 1,250 feet below the limestone in the northwest corner of the area, as shown in the Hazlewood and Evans wells, to 1,490 feet in the Lewis Baker well near Slate Lick. Owing to the difficulty of identifying this sand outside of the oil-producing territory, there may be a misinterpretation of the record of the Baker well and a lower sand mistaken for the Fourth. However that may be, the interval from the limestone to the bottom of the Fourth sand, and therefore to the bottom of the group, increases from north to south just as the intervals to the top of the Murrysville sand and to the top of the Venango sands increase.

In the Rural Valley quadrangle the lowest sands of the group are not well developed, and the Fourth sand generally can not be identified. In 16 wells the bottom of the Fourth

[a] Carll, John F., Second Geol. Survey Pennsylvania, Rept. XIII, p. 130.

sand varies from 1,262 to 1,435 feet. In the same wells the thickness of the group varies from 306 to 485 feet, the mean thickness being 386 feet. Thirty-four wells in the Kittanning quadrangle give an average interval of 1,347 feet between the limestone and the bottom of the Fourth sand, and an average thickness for the group of 363 feet.

Second or Hundred-foot sand.—The uppermost of the Venango oil sands is a bed of sandstone which is called the Second sand in the oil region of northern Butler County, and Hundred-foot sand throughout the gas-bearing territory of Armstrong County. It was regarded by Carll as the equivalent of the First sand of Venango County, the change in name being due to a mistake in the identification of sands when drilling began in northern Butler County. In many places this sand is an unbroken bed 150 feet thick, but in others it is separated by thin bands of shale into two or three members, which in descending order are called Second or Hundred-foot sand, Fifty-foot sand, and Thirty-foot sand. So far as the writer is aware, this bed has never produced oil in these quadrangles, but it is one of the important gas-bearing rocks of Armstrong County.

Blue Monday and Boulder sands.—Near the center of the group are two thin sand beds, which in descending order are known as the Blue Monday and Boulder sands. Generally they are nonproductive and of no economic importance.

Stray, Third, and Fourth sands.—These are the great oil-bearing beds, and they constitute the lower part of the group. When drilling began in Butler County, the first oil-bearing sand was called the Venango Third sand. Later a lower productive sand was discovered, which was then called the Fourth sand. Carll [a] believes, with good reason, that the correlation of the Third sands of Butler and Venango counties is a mistake; that the Butler Third is equivalent to the Venango Second sand, and that the Butler Fourth is represented by the Venango Third sand. However that may be, the names originally adopted for the sands in this region will be used here. These names have been applied to the various oil-producing sands of the region according as the drillers believed that they could identify them as the one or the other, and consequently the oil-producing territory has been divided into Third sand pools, Fourth sand pools, etc. Where the sand could not be referred to either of these two main beds, the name of Stray sand has been adopted, making here and there a Stray sand pool. The Stray sand is regarded as occupying a higher position than the Third sand.

Outside of the pool in northern Butler County, where the names were first applied and where both the Third and Fourth sands occur, the one above the other, it is doubtful whether the different sands can be identified with any degree of certainty, or whether the Third sand of one locality is the same as the Third sand of another locality, and so on.

The Third sand yields a little gas in a few wells in the southern part of the Kittanning quadrangle.

Variations.—The remarks concerning the variability of the Murrysville sand apply equally well to the various Venango sands. The latter are not persistent but fugitive beds. They appear, increase in thickness, thin out, disappear, and their places are taken by other beds of similar character at a little higher or a little lower horizon, or farther on at the same horizon. Thin beds of sandstone may be separated by thin bands of shale, the shale bands may disappear, and a thick bed of sandstone take their places, or vice versa. Thus there are endless variations, such as may be seen where the beds can be traced at the surface. About the most that can be safely said is that in some localities one or more of the sandstone beds occurring toward the bottom of the group bears oil in paying quantities.

FIFTH SAND.

The fifth sand is recorded in various wells from 50 to 100 feet below the oil sands. It is generally thin. It is an important source of gas in a number of wells in the southern part of the quadrangles.

[a] Carll, John F., Second Geol. Survey Pennsylvania, Rept. XIII, p. 130.

SPEECHLEY SAND.

This is called the Speechley sand because it is correlated with the sand of that name in Venango and Forest counties. Whether or not that correlation is correct can not at present be determined, but the name is accepted here.

This sand lies at varying depths below the Vanport limestone. In the Amos Steele well (245) in Bradys Bend Township, a sand at 2,030 feet below the Vanport limestone was called the Speechley sand; in the Rayburn well (182) near Slate Lick, the Speechley was recorded at 2,309 feet below the limestone. In six wells in the Rural Valley quadrangle the interval between the limestone and the Speechley sand varies only between 2,210 and 2,240 feet. The mean interval between the two beds in nine wells in the Kittanning quadrangle is 2,200 feet and in six wells in the Rural Valley quadrangle is 2,227 feet. The Speechley rarely exceeds a thickness of 50 feet and is frequently less. In the Colwell well (543) at Mahoning Furnace, two benches of sandstone in contact are recorded, the lower of which is called the Speechley. It seems more likely that the two should be regarded as the Speechley, and that it has here an unusual thickness. In the Moore well (485) a thin sand, called the Second Speechley, is recorded, 100 feet below the Speechley.

TIONA SANDS.

Within 150 feet below the Second Speechley lie the first and second "Tiona" sands. This name probably expresses the belief that these sands are to be correlated with the Tiona oil sands of Warren County. Such long-distance correlation has, however, but little value. The sand noted as Speechley in the Colwell well (543) is probably one of the Tiona sands, while the thin sand 150 feet above is probably the true Speechley. The facts appear to be that the zone 200 feet thick, beginning above with the first Speechley sand, is marked by beds of sandstone of greater or less development, one or more of which may be locally good gas producers.

As already stated, the Speechley sand is an important gas producer only in the vicinity of Slate Lick and Worthington, in the Kittanning quadrangle, and near Muff, in the Rural Valley quadrangle. According to the latest information received by the writer, the Tiona sand yields gas only in the vicinity of Goheenville.

NO GAS BELOW THE TIONA SANDS.

Several wells in the two quadrangles have penetrated over 1,000 feet below the Speechley and Tiona sands without reporting either gas or oil, and the probabilities seem strongly against either ever being found in commercial quantities below the level of those sands.

STRATIGRAPHIC RELATIONS OF OIL AND GAS SANDS.

As fully shown on page 26, in the discussion of rocks not exposed, it seems probable that the Murrysville sand, the Hundred-foot sand, including its lower bench, and the Thirty-foot sand are included in the lower portion of the Pocono formation, the lower oil sands to the bottom of the Fourth sand are included in the Catskill formation, and the Speechley and Tiona sands occur at considerable depth in the Chemung formation.

AREAL DISTRIBUTION OF OIL AND GAS.

Oil pools.—By examining the structure-economic map it can be seen that the oil and gas of the quadrangles are not distributed uniformly throughout the beds in which they occur. In the first place, the portions of the quadrangles yielding the two substances are rather sharply separated, the oil-producing territory being confined to the western side, to the northwest corner, and to the northern margin west of Allegheny River. Throughout the remainder of the quadrangles only gas occurs.

Within the oil-producing territory the drill has revealed the fact that in certain well-defined areas the oil has accumulated in much greater quantities than in the surrounding

areas, in which oil wells are comparatively scattering and much less productive. These very productive areas are generally elongated and comparatively narrow, and are called belts or pools. What is true of the accumulation of oil is also true of the accumulation of gas, as shown below on this page. The mapping of the oil pools is based upon the grouping of producing wells at the present day, and may not fully represent the pools as they existed previous to the drilling of the territory. It is probable that many more large wells were drilled between Chicora and Karns than now remain, and that that region constituted one of the most important belts of the quadrangle.

Gas fields.—The gas-bearing territory of the quadrangles is more or less completely separated into several fields by areas of comparatively unproductive territory. These are the Winfield field, lying in Winfield, West Franklin, and North Buffalo townships; the Madison field, lying in Madison, Washington, and the northern part of East Franklin townships; the Glade Run field, lying to the west of Glade Run in eastern North Buffalo and southern East Franklin townships; the Limestone Run field, near the mouth of that stream, and the Cowanshannock field, including most of Kittanning, Cowanshannock, Valley, Boggs, and Wayne townships. In addition to these there are several smaller fields—one just east of Ford City, one along Garrett Run, one at Atwood, another north of Mahoning Furnace, and one in Redbank Township in the northeast corner of the Rural Valley quadrangle. All these contain comparatively few wells, and the product of these is generally not large. The one east of Ford City, developed in 1902, is the most important. A number of good wells were drilled, but the field proved to be of small extent.

Gas does not occur in the deepest parts of the synclines, though there are some apparent exceptions to the rule. In the vicinity of Slate Lick a few paying wells have been drilled to the Speechley sand in the bottom of the Boggsville syncline. Even here, however, the rocks are rising from the deeper part of the syncline to the locality of the well. A number of good wells were obtained in the Murrysville sand at Ford City, near the axis of the Fairmount syncline, but they are 100 feet above the bottom of the syncline. The two wells on the Starr farm south of Hays Run are on the axis of the Fairmount syncline, but on the crest of a low cross anticline that separates the depression on Pine Creek from the portion of the syncline farther south. The wells in the vicinity of Mosgrove and on Garrett Run, though near the synclinal axis, are still about 100 feet above the bottom of the basin. Southeast of Blanco there are two light wells in the Apollo syncline, but here again is a low cross anticline. In the vicinity of Rural Valley there are a few wells in the flat-lying strata fringing the base of the Greendale anticline, but dry holes have been the general result of drilling at greater distances from the anticline. Near Atwood a few wells have been obtained, but the records of these wells indicate a slight anticlinal structure at that place. The wells in the northeast corner of the Rural Valley quadrangle are near the crest of a pronounced anticline.

The conclusion can safely be drawn that gas has, in the main, accumulated along the anticlines and that the synclines are practically barren, though how far down on the flanks of the anticlines gas may have accumulated in paying quantities only the drill can reveal. It is now a generally accepted theory that structure exercises an important influence upon the accumulation of gas and oil, which tend to accumulate on the crests and along the flanks of the anticlines—gas at the top, oil next below, and water at the bottom, this distribution being in accordance with the relative densities of the substances. This is known as the anticlinal theory. Structure, however, is not the only determining factor in the accumulation of gas, for dry holes are occasionally drilled on the crests of anticlines, as is shown in this region by the Ruffner well, in Kittanning Township, and the H. S. Pontius well, in Wayne Township east of Belknap. In such cases the sands may be absent or not of sufficiently open or porous character to receive the gas and yield it up readily when tapped.

It has been customary in the past to locate wells with reference to a line drawn at some particular angle from another well, as along a line extending through a well at an angle of N. 30° or 45° E., etc., probably on the assumption that structure lines followed the straight

courses mapped by the Second Geological Survey of Pennsylvania. The better knowledge of the structure of the region now available shows the futility of such a method.

Possible extension of gas fields.—The anticlinal theory seems to be supported by all the developments in these quadrangles, and the directions in which future drilling may be done with a reasonable hope of success can be readily determined by the study of the map, which shows the position of the anticlines and the location of most of the existing wells. The writer would venture to suggest a few areas in which drilling might be done with favorable results. One such area of large extent lies along the southeastern flank of the Kellersburg anticline from Mahoning to New Bethlehem. Another extends along the northwestern flank of the Greendale anticline from Goheenville to the eastern margin of the Rural Valley quadrangle, with a mostly untested area of considerable breadth extending southward by Belknap to North Branch of South Fork of Pine Creek. The region along the Kellersburg anticline from Craigsville to the river does not appear to have been very thoroughly drilled, and might repay further testing. Those interested can easily find other areas of undrilled territory along the anticlines.

PARTIAL RECORDS OF OIL AND GAS WELLS.

Partial records of 549 wells in the Kittanning and Rural Valley quadrangles are given below in tabular form. These records have been kindly furnished by the larger companies, private individuals, and contractors, and as a general thing are published by permission. The table includes the depth and thickness of all economic beds given in the records, such as coal seams, limestones, and oil and gas sands. It is hoped that this information may prove helpful to those interested in developing the mineral resources of the quadrangles.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles.

WINFIELD TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		Feet.	Feet.		Feet.	Feet		Feet.	Feet.	Feet.	
1	Ellis Hasselgesser	Pittsburg Plate Glass Co.	1,250				Vanport	540	15	Murrysville	1,459	26	2,067	Little gas in Fourth sand.
							Mercer?	730?		Hundred-foot	1,614	65		
										Th'rd	1,775	37		
										Fourth	1,912	21		
2	Casper Freehling No. 3	do	1,290	Upper Freeport	250	3	Freeport?	253	5	Murrysville	1,430	15	1,700	Moderate gas in Murrysville at 1,430.
							Vanport	545	15	Hundred-foot	1,588	112		
3	Casper Freehling No. 1	American Natural Gas Co.	1,250							Murrysville	1,367	21	1,521	Gas in Hundred-foot at 1,521.
										Hundred-foot	1,507			
4	Painter heirs	Pittsburg Plate Glass Co.	1,190	Upper Freeport	200	3	Vanport	453	15	Murrysville	1,338	25	1,575	Considerable gas in Murrysville.
							Mercer	613	17	Hundred-foot	1,498	54		
5	J. B. Bricker's heirs	do	1,260				Freeport	247		Murrysville	1,355	30	2,000	Gas in Hundred-foot at 1,515.
							Vanport	484	10	Hundred-foot	1,493	79		
							Mercer	655	12	Fourth	1,805	60		
										Fifth?	1,960	10		
6	H. E. Heller No. 2	G. L. Cabot	1,280				Vanport	510	20	Murrysville	1,385	20	1,952	
										Hundred-foot	1,530	70		
										Third	1,800	30		
										Fourth	1,860	35		
										Fifth	1,920	20		
7	Calvin Cruikshank	Pittsburg Plate Glass Co.	1,310	Brush Creek?	149	1	do	463	11	Murrysville	1,320	150	1,525	
										Hundred-foot	1,510			
8	P. J. Heck No. 1	G. L. Cabot	1,295				do	423	20	do	1,400	80	1,906	Gas in Hundred-foot at 1,470; gas in Fifth sand at 1,862.
										Fourth	1,750	18		
										Fifth	1,855	40		

9	Robt. Smith	Pittsburg Plate Glass Co.	1,360				do	475		Murrysville	1,372	15	3,571	A little gas in Speechley.
										Hundred-foot	1,514	86		
										Third	1,780	10		
										Fourth	1,815	25		
										Fifth?	1,875	25		
										Speechley	2,700	23		
10	H. E. Heller No. 1	G. L. Cabot	1,200				do	375	15	Murrysville	1,270	20	2,680	Gas at 2,641.
										Hundred-foot	1,410	80		
										Third	1,700	18		
										Fourth	1,736	20		
										Fifth	1,795	20		
										Speechley	2,627	31		
11	Bower No. 2	Home Gas Co.	1,070				do	312		Murrysville	1,170		1,756	Gas in Murrysville at 1,18[illegible]; gas in Hundred-foot at 1,370.
										Hundred-foot	1,350			
										Fourth	1,670			
										Fifth	1,730			
12	Joshua Gilreath No. 1	G. L. Cabot	1,040				do	310		Hundred-foot	1,370		1,808	Gas at 1,180; gas in Hundred-foot at 1,350; rock pressure 300 pounds.
										Fifth	1,735			
13	J. G. Freehling	do	1,230				do	458		Murrysville	1,355		1,587	Gas in Hundred-foot at 1,510.
										Hundred-foot	1,470			
14	C. J. Noble	Pittsburg Plate Glass Co.	1,340				do	478	12	Murrysville	1,304	30	1,467+	Gas in Murrysville at 1,315; good gas in Hundred-foot at 1,467; rock pressure 80 pounds.
							Mercer?	603		Hundred-foot	1,453			
15	J. M. Smith	G. L. Cabot	1,345				Vanport	410	20	Murrysville	1,205		1,285+	Gas in Murrysville at 1,267 and 1,285.
16	Geo. W. Watson No. 1	American Natural Gas Co.	1,360							do	1,330		1,558	Gas in Hundred-foot at 1,510.
										Hundred-foot	1,470			
17	John F. Bricker No. 1	do	1,340				Vanport	445		Murrysville	1,340		1,761	Gas in Murrysville at 1,345.
18	Henry Ronneigh No. 1	T. W. Phillips	1,310							Hundred-foot	1,500		1,939	Gas at 1,344.
19	J. M. Smith No. 4	G. L. Cabot	1,340							Murrysville	1,268	25	1,605	Gas in Murrysville at 1,290; gas in Thirty-foot at 1,450.
										Hundred-foot	1,365	70		
										Thirty-foot	1,445	35		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

WINFIELD TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Thickness.	Oil and gas sands. Depth.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
20	J. M. Smith No. 1	G. L. Cabot	1,410				Vanport	455	18	Murrysville	1,300	25	1,971	Gas in Murrysville at 1,305; gas in Fifth at 1,868.
										Hundred-foot	1,480	80		
										Third	1,685	15		
										Fourth	1,800	20		
										Fifth	1,865	15		
21	John F. Bricker No. 2	American Natural Gas Co.	1,410							Murrysville	1,290	40	1,523	Gas in Murrysville at 1,295.
										Hundred-foot	1,470	53		
22	W. L. Gibson No. 1	G. L. Cabot	1,320				Vanport	453	18	Murrysville	1,330	20	1,572	Produces gas.
										Hundred-foot	1,470	50		
23	L. H. Bicker No. 2	do	1,420				do	452		Murrysville	1,335		1,922	Do.
										Fifth	1,880			
24	L. H. Bicker No. 1	do	1,330				do	370	20	Murrysville	1,200		1,807	Gas in Murrysville at 1,200; gas in Hundred-foot at 1,400; gas in Fifth at 1,790.
										Hundred-foot	1,380			
										Fifth	1,785			
25	F. Witte No. 4	do	1,370				do	400		Murrysville	1,290			Dry.
										Hundred-foot	1,400			
										Fourth	1,760			
										Fifth	1,827			
26	Clymer No. 1	American Natural Gas Co.	1,070				do	155		Murrysville			1,050	Gas in Murrysville at 1,041.
27	McKee Furnace No. 2	do	880							Hundred-foot	1,000		1,053	Gas in Hundred-foot at 1,026.
28	McKee Furnace No. 1	do	920							Murrysville	845		1,050+	Gas in Murrysville at 855; gas in Hundred-foot at 1,050.
										Hundred-foot	1,016			

29	McComb Painter No. 2	Home Gas Co.	1,385							Fourth?	1,790		1,855	Gas at 1,300; gas at 1,610; gas in Fifth at 1,828.
										Fifth	1,824			
30	Henry Ronneigh heirs No. 1.	G. L. Cabot	1,390				Vanport	410						
31	McKee Furnace No. 3.	American Natural Gas Co.	980							Murrysville	835		1,030	Gas in Hundred-foot at 1,020.
										Hundred-foot	1,000			
32	McComb Painter No. 1	Home Gas Co.	1,180							do	1,245			Gas at 1,050; gas in Hundred-foot at 1,625 and 1,260.
33	John Denny No. 1	John Denny	1,010				Vanport	25						
34	Lewis Helm No. 1		1,060				do	85		Murrysville	965		1,620	Gas in Third? at 1,300.
										Hundred-foot	1,137			
										?	1,300			
										Fourth?	1,433			
										Fifth?	1,488	30		
35	Laurence Denny	T. W. Phillips	1,070				do	175						
36	Steven McCafferty	Home Gas Co.								Murrysville	1,005	66	1,550	Gas in Murrysville at 1,010.
										Hundred-foot	1,160			
										Third?	1,447			
										Fourth?	1,505			
37	John Denny No. 2	T. W. Phillips	1,235							Hundred-foot	1,445		1,853	Gas at 1,290; gas in Fifth at 1,825.
										Third?	1,700	30		
										Fourth?	1,749	41		
										Fifth	1,825			
38	McLafferty	Home Gas Co.	1,380?				Vanport	344		Murrysville	1,252		1,280	Produces gas.
39	J. M. McLaughlin	do	1,200?				do	170		do	1,057		1,087	Do.
40	Daniel McLaughlin	do	1,220?				do	178		do	1,051		1,077	Do.
41	Wm. A. Magee No. 2.	Pittsburg Plate Glass Co.	1,115				do	85	22	do	950	40	1,159	Gas in Murrysville at 960; gas in Hundred-foot at 1,090.
										Hundred-foot	1,085	10		
42	Wm. A. Magee No. 3.	do	1,230				do	172	22	Murrysville	1,040	10	1,070	Gas in Murrysville at 1,040.
43	M. J. Sloan No. 1	T. W. Phillips	1,330							Hundred-foot	1,317		1,667	Oil in Fourth at 1,672; flowed 7 barrels.
										Third	1,651			
										Fourth	1,667	50		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

CLEARFIELD TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
44	Donahue No. 4	T. W. Phillips	1,330							Hundred-foot	1,388		1,713	Oil at 1,689.
										Fourth?	1,685			
45	Wm. A. Magee No. 1	Pittsburg Plate Glass Co.	1,250				Vanport	180	25	Hundred-foot	1,225	65	1,753	Gas in Hundred-foot at 1,235; gas in Fifth at 1,605.
										Third?	1,530	15		
										Fourth?	1,538	27		
										Fifth?	1,600	12		
46	Patrick Logue No. 3	T. W. Phillips	1,240							Hundred-foot	1,262		1,650	Oil in Third sand pumped 10 barrels.
										Third	1,578			
										Fourth	1,609	37		
47	Patrick Logue No. 4	do	1,300							Hundred-foot	1,355		1,745	Gas in Hundred-foot at 1,395; oil in Fourth sand at 1,709; pumped 25 barrels.
										Third	1,670			
										Fourth	1,705	38		
48	McGucken	do	1,290				Vanport	200?		Hundred-foot	1,245			
										Fourth	1,511	59		
										Fifth	1,615	10		
49	John McLaughlin	do	1,330				do	270		Hundred-foot	1,265		1,931	Dry.
										Third	1,570			
										Fourth	1,608	32		
50	H. McCrea No. 3	Hildebrand Oil Co.	1,400				do	412		Hundred-foot	1,400			Produces oil.
										Fourth	1,748			
51	H. McCrea No. 2	do	1,400				do	400						Do.
52	H. McCrea No. 1	do	1,380				do	380						Do.
53	John Swain No. 1		1,380				do	396						Do.

54	Patrick McBride No. 1	T. W. Phillips	1,310							Hundred-foot	1,410		1,900	Produces gas.
										Third	1,725	25		
										Fourth	1,770	33		
55	M. Welland	Frank McBride	1,280	Upper Freeport.	170	4?	Vanport	380?	15	Hundred-foot	1,415	120	1,808	A little gas in Hundred-foot at 1,420.
				Upper Kittanning?	310	12?				Third	1,690			
										Fourth	1,773	27		A little oil at 1,698; abandoned.
56	McShane No. 4	Reese, Marshall & McCollum.	1,315	Upper Freeport.	188	5	Vanport	470	15	Murrysville	1,300	60	1,925	Oil in Third sand.
										Hundred-foot	1,415	95		
										Third	1,680	45		
										Fourth	1,726	44		
57	Coyle No. 1	Fisher Oil Co	1,245				do	359	24	Murrysville	1,225	65		Oil in Third.
										Hundred-foot	1,355	50		
										Third	1,614	52		
58	Chas. Reiley No. 8	Campbell & Murphy	1,185				do	265	20	Murrysville	1,115	30	1,529	Gas in Murrysville at 1,120.
										Hundred-foot	1,240	90		
										Third	1,496	33		Oil in Third at 1,506 to 1,514.
59	Chas. Reiley No. 5	do	1,290				do	390	20	Murrysville	1,230	35	1,650	Oil in Third at 1,630 to 1,640; gas at 1,255 and 1,375.
										Hundred-foot	1,350	50		
										Third	1,621	29		
60	Chas. Reiley No. 6	do	1,280				do	388	20	Murrysville	1,230	30		Oil at 1,628 to 1,635.
										Hundred-foot	1,340	60		
										Third	1,618	33		
61	Chas. Reiley No. 4	do	1,290				do	388	20	Murrysville	1,210	40	1,625	Oil at 1,610 to 1,614; gas at 1,215 and 1,355.
										Hundred-foot	1,305	65		
										Third	1,598	27		
62	Chas. Reiley No. 2	do	1,260				do	350	20	Murrysville	1,200	30	1,618	Oil at 1,594 to 1,602; gas at 1,205.
										Hundred-foot	1,320	60		
										Third	1,582	36		
63	Chas. Reiley No. 7	do	1,230				do	343	20	Murrysville	1,110	100		Oil at 1,568 to 1,574; flowed 80 barrels first 24 hours.
										Hundred-foot	1,290	95		
										Third	1,553	31		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

DONEGAL TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
64	Harvey & Dolan No.3	Thos. F. Harvey	1,280				Vanport	376		Third	1,600		1,639	Oil at 1,608.
65	Fisher No. 1	do	1,215				do	280		Murrysville	1,137		1,584	Oil in Third sand.
										Hundred-foot	1,265	100		
										Third	1,512	72		
66	Brady & Simpson No.1	do	1,225				do	246		do	1,470		1,539	Do.
67	Harvey & Dolan No.2	do	1,280				do	335		do	1,586		1,632	Oil at 1,591.
68	Reep & Sutton No. 1	do	1,190				do	258		do	1,481		1,528	Oil at 1,491.
69	Hickey No. 3	Fisher Oil Co	1,150				do	352	22	Murrysville	1,170	50		
										Hundred-foot	1,365	50		
										Third	1,609			
70	Brady & Simpson No.2	Thos. F. Harvey	1,225				do	202		do	1,485		1,542	Oil at 1,493.
71	Hickey No. 12 ?	Fisher Oil Co	1,120				do	440	20	Hundred-foot	1,360	95	1,740	
										Fourth?	1,679	51		
72	Hickey No. 7	do	1,130				do	380	20	Murrysville	1,217	25		Oil in Third sand at 1,603.
										Hundred-foot	1,418	90		
										Third	1,627	33		
73	Breadon No. 1	Finnessy & Young	1,160				do	238		do	1,493		1,525	Oil at 1,501.
74	Gillespie No. 1	do	1,075				do	160		do	1,400	14	1,426	
75	Michael Maley No. 1	John Black & Co	1,290	Lower Kittanning.	193	4	do	217	20	Fourth?	1,467			
76	Daniel Goldlinger No.2	do	1,340	do	284	4	do	324	20	do	1,594			Produces oil.
77	Daniel Goldlinger No.1	do	1,330	do	320	4	do	360	20	Fourth	1,630	43		Do.
78	Hildebrant No. 4	Seybert Bros	1,340				do	416		Hundred-foot	1,406			Do.
										Third	1,565			

79	Hildebrant No. 7	do	1,340				do	396		Hundred-foot	1,386			Do
										Third	1,636			
80	Hildebrant No. 6	do	1,341				do	404		Hundred-foot	1,394			Do.
										Third	1,642			
81	Hildebrant No. 1	do	1,311				do	348		Hundred-foot	1,358			Do.
										Third	1,595	42		
82	Hildebrant No. 3	do	1,266				do	322		Hundred-foot	1,312			Do.
										Third	1,560			
83	Hildebrant No 2	do	1,270				do	323		Hundred-foot	1,313			
										Third	1,561	42		
84	Hildebrant No. 5	do	1,250				do	297		Hundred-foot	1,287			Do.
										Third	1,532			
85	Chas. Duffy No. 1	Christian Garing								do	1,400			Do.
86	Jno. King No. 4	Scharbach & Co	1,220	Lower Kittanning.	192		Vanport	232		do	1,487	38		Oil at 1,501.
87	Jno. King No. 3	do	1,235	do	226	4	do	264		do	1,505	34		Oil at 1,515.
88	Jno. King No. 2	do	1,320	do	292	4	do	332	20	do	1,573	33		Oil at 1,583.
89	Thos. Rogers No. 1	do	1,185				do	205						
90	Bradys Bend tract No. 18.	Hunter & Cummings	1,150	Lower Kittanning.	60	2	do	210	20	Hundred-foot	1,151			
										Third	1,461	23		Produces oil.
91	Bradys Bend tract No. 21.	do	1,140?				do	190		do	1,446	27		Do.
92	Bradys Bend tract No. 20.	do					do	257		Third?	1,473	50?		Do.
93	Bradys Bend tract No. 19 (Robt. Munroe's).	do	1,265				do	315	20	Murrysville	1,140	30		Abandoned.
										Hundred-foot	1,270			
										Third	1,536	54		
94	Ransell No. 2	Christian Garing	1,240							do	1,547			
95	John Black No. 5	John A. Black & Co	1,140				Vanport	159		do	1,436	40		
96	Black No. 4	do	1,150				do	164		do	1,422	35		
97	McKeever No. 1?	Jno. P. McKeever	1,210				do	240?						
98	Will No. 1	Daniel Burns	1,285				do	270	19	Third	1,520	22		Oil at 1,524 to 1,530.
99	Will No. 2	do	1,350				do	325	20	do	1,576	22		Oil at 1,579 to 1,594.
100	James L. Double	Wm. Peters	1,390				do	372						

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

DONEGAL TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
101	Chris. Michaels No. 1	P. L. Burns	1,275				Vanport	245	21	Third	1,468	21		Oil in Third at 1,473.
102	A. Black No. 1		1,300	Lower Kittanning.	295		do	335		do	1,571	33		
103	C. F. Vensel No. 1	C. F. Vensel	1,370				do	381		do	1,598		1,652	Oil at 1,610 and 1,620.
104	C. F. Vensel No. 2	do	1,370				do	390		Murrysville	1,220			
										Hundred-foot	1,365			Gas in Murrysville.
										Third	1,607	51		Produces oil.
105	Pontius No. 3			Lower Kittanning.	255		do	295		do	1,530			
106	Henry PontiusNo. 2	Westermann Bros	1,320							do	1,525			
107	Henry Pontius No. 1	do	1,290							do	1,511	43		Oil at 1,513.
108	S. L. Pontius No. 4	Hunter & Cummings	1,390				Vanport	428	20	do	1,640	61		
109	S. L. Pontius No. 2	do	1,380				do	402	18	do	1,610?	61		
110	S. L. Pontius No. 1	do	1,350	Upper Freeport	120	2	do	366	18	Hundred-foot	1,330	80		
				Lower Freeport	142	8?				Third?	1,561	36		
				Upper Kittanning.	249	4								
				Lower Kittanning.	325	3								
				Clarion	410	2								
				Brookville	448	2								
111	S. L. Pontius No. 10	do	1,330?							Third	1,510	113		
										Fourth	1,640	14		
112	I. Reep No. 3	Westermann Bros	1,395							Fourth	1,701	16	1,730	
113	I. Reep No. 5	do	1,370							Fourth	1,701	20		Produces oil.

114	I. Reep No. 6	do	1,390						do	1,710	14	1,688	Do.
115	Will No. 3	Titley & Co	1,360						Fourth?	1,652			Do.
116	Myers No. 1	do	1,370						Fourth	1,660			Do.
117	Shakeley No. 2	do	1,405						Third	1,642			Do.
118	Kammerer No. 4	do	1,410			Vanport	402		do	1,621			Do.
119	Kammerer No. 1	S. H. Kammerer & Co	1,410			do	424?		do	1,614			Do.
120	Graveyard well	do	1,360						do	1,585			Do.
121	Amos Reep No. 1	Kammerer Bros	1,430						do	1,673			Do.
122	Sain No. 1	S. H. Kammerer & Co.	1,400						do	1,607			Do.
					FAIRVIEW TOWNSHIP.								
123	S. W. McCullough	Pontius, McCullough & Co.	1,310						Third	1,532			Dry.
124	S. H. Kammerer No. 1	S. H. Kammerer	1,370						do	1,592	29		Produces oil.
125	King heirs No. 1	Seybert Bros	1,375						Hundred-foot	1,322			Do.
									Third	1,562	28		
126	Wm. Kammerer heirs No. 1.	Kammerer Bros	1,350			Vanport	370		do	1,564			Do.
127	D. & J. King No. 1	Seybert Bros	1,280						Hundred-foot	1,232			Do.
									Third	1,474	27		
128	King heirs No. 2	do	1,370						Hundred-foot	1,330			Do.
									Third	1,570	24		
129	Kaylor No. 4	do	1,370			Vanport	368		Hundred-foot	1,330			Do.
									Third	1,561	26		
130	John Kaylor	W. S. McCullough & Sons.	1,360			do	320						Do.
131	Kaylor No 3	Seybert Bros	1,305			do	323		Hundred-foot	1,283			Do.
									Third	1,512	26		
132	Kaylor No. 1	do	1,345			do	320		Hundred-foot	1,282			Do.
									Third	1,510	28		
133	Kaylor No. 2	do	1,365			do	345		Hundred-foot	1,316			Do.
									Third	1,544	24	1,647	
134	E. G. Frederick	Westermann Bros	1,460			do	460						Do.
135	Geo. Kemer	J. C. Widger	1,420			do	447					1,717	Do.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

FAIRVIEW TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
136	Thorn	Westermann Bros.	1,436				Vanport	460		Third	1,643			Produces oil.
										Fourth	1,720		1,736	
137	Gilbert Bros. No. 2		1,295				do	299	23	Third	1,469	15		
										Fourth	1,537	12		
138	Sendler	McMeekin Bros.	1,360							Third	1,550		1,632	
139	Harrington	Mrs. John Clark	1,410?				Vanport	448	10	do	1,650			
140	Lawrence McLaughlin.	Producers' Oil Co.	1,410	Upper Freeport?	150		do	430						
				Lower Kittanning?	375									
				Clarion ?	477									
141	Andrew Mays No. 1	Davis Bros.	1,270				do	212		Hundred-foot	1,212		1,536	Oil at 1,524.
										Fourth	1,512			
142	Andrew Mays No. 2	do	1,310				do	287		Hundred-foot	1,287		1,604	Oil at 1,594.
										Fourth	1,587			
143	Andrew Mays No. 3	do	1,350				do	294		Hundred-foot	1,294		1,618	Oil at 1,598 to 1,618.
										Fourth	1,594			
144	David Kaylor No. 2	C. W. S. Peters	1,460				do	410		Hundred-foot	1,352			Produces oil.
										Fourth	1,685			
145	David Kaylor No .3	do	1,458				do	410		Hundred-foot	1,356			Do.
										Fourth	1,681			
146	David Kaylor No. 4	do	1,460				do	416		Hundred-foot	1,362			Do.
										Fourth	1,689			
147	W. H. H. Riddle No. 5.	T. R. Storey	1,400				do	413		Third	1,590			Do.
										Fourth	1,660			

148	W. H. H. Riddle No. 6	do	1,460				do	471		Third	1,648			Do.
										Fourth	1,711			
149	W. H. H. Riddle No. 7	do	1,400?				do	438		Third	1,681			Do.
150	W. H. H. Riddle No. 1	do	1,230				do	243		do	1,420	15	1,438	Do.
151	W. H. H. Riddle No. 2	do	1,250				do	255		do	1,432	13		Do.
152	W. H. H. Riddle No. 3	Riddle Farm Oil Co	1,280				do	280		do	1,457	19	2,460	Oil in Third and Fourth sands; a little gas in Speechley.
										Fourth	1,524	19		
										Speechley?	2,380	3		
153	S. Riddle No. 7	Hazelwood Oil Co	1,350 ?							Third	1,525		1,591	Produces oil.
154	Harmon No. 1	do	1,315							do	1,500		1,514	Drilled to Fourth, but no oil.
155	Storey No. 5	do	1,470							do	1,662		1,697	Do.
156	Storey No. 4	do								do	1,586		1,671	Do.
157	McClyman	Mattison & McDonald	1,244?				Vanport	165	20	do	1,390	12		Oil, 75 barrels per day.
										Fourth	1,470	20		
158	Madison well	E. E. Abrams	1,235				do	204		Hundred-foot	1,135	100		
										Third	1,377	20		
										Fourth	1,447			
159	Armenia well	do	1,195							Third	1,364	14		
160	P. R. Burke No. 1	P. R. Burke					Vanport	223	23	Hundred-foot	1,153	100	1,510	Dry.
										Third	1,408	20		
										Fourth	1,476	30		
161	Bermuda well	E. E. Abrams								Third	1,407	20		Produces oil.

SOUTH BUFFALO TOWNSHIP.

162	D. C. Boggs	Pittsburg Plate Glass Co.	890				Loyalhanna??	470	25	Third?	1,530	10		Murrysville and Hundred-foot both absent from this record.
163	Drake No. 1	American Natural Gas Co.	860				Vanport	165	18	Murrysville	1,095	30		
										Hundred-foot	1,160	100		Gas in Murrysville at 1,130.
										Third	1,590	25		
										Fourth	1,650	90		
164	Bickett Bros. No. 1	do	867							Murrysville	1,094	26		Produces gas.
165	H. C. Bricker	do	900				Vanport	220						Do.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

SOUTH BUFFALO TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
166	Samuel Burnes No. 1.	American Natural Gas Co.	882	....	......	......	....	......	......	Murrysville...	1,120	......	1,140	Produces gas.
167	Chas. Myers..........	Pittsburg Plate Glass Co.	1,195	Upper Freeport.	193	3	Vanport..	456	16	.....do.........	1,360	30	....	
				Lower Freeport?	250	5	....	......	......	Hundred-foot	1,460	105	....	
										Fourth.......	1,895	12	2,014	Dry.
							NORTH BUFFALO TOWNSHIP.							
168	J. Weaver No. 1......	Carnegie Natural Gas Co.	1,213	Upper Freeport.	255	4	....	......	......	Hundred-foot	1,540	100	2,890	Gas in Speechley; minute pressure: $\frac{1}{20}$, $\frac{2}{40}$, $\frac{3}{50}$, $\frac{4}{65}$, $\frac{5}{80}$; rock pressure 900 pounds.
										Third.........	1,830	25		
										Fourth.......	1,900	40		
										Fifth.........	2,000	20		
										Speechley.....	2,813	50		
169	R. Z. McClatchey.....	Pittsburg Plate Glass Co.	1,213	Brush Creek ?..	180	5	....	......	......	Hundred-foot	1,560	135	2,868	Gas in Hundred-foot at 1,600; gas at 1,940; gas in Speechley at 2,820 and 2,835.
				Upper Kittanning?	400	5	....	......	......	Third.........	1,830	20		
										Fourth.......	1,915	55		
										Fifth.........	2,000	10		
										Speechley.....	2,818	42		
170	Ralston heirs No. 1..	.....do...............	1,175	Lower Kittanning?	340?	4	Vanport..	374	21	Murrysville...	1,270	55	....	Gas in Hundred-foot at 1,490; considered dry.
				Clarion.........	410	3	Mercer? ..	545	25	Hundred-foot	1,395	110		
										Third.........	1,705	30		
										Fourth.......	1,785	61		
										Fifth.........	1,905	15		

171	Pump Station No. 1 well.	....do....	900	Clarion....	20	4	....			Murrysville...	865	45	1,555	Gas in Hundred-foot at 1,065; gas in Fifth at 1,415.
										Hundred-foot	1,000	100		
										Third ?....	1,250	83		
										Fifth ?....	1,415	25		
172	T. J. Ewing No. 2	....do....	1,120	Upper Kittanning?	145	5	Vanport..	262	23	Murrysville...	1,155	50	1,820	Gas in Hundred-foot at 1,360; gas at 1,503; gas at 1,708.
				Clarion....	305	5	....			Hundred-foot	1,285	145		
										Third ?....	1,570	125		
										Fifth....	1,705	25		
173	T. J. Ewing No. 1	....do....	1,230	....			Vanport..	380	23	Murrysville...	1,315	15	....	Gas in Hundred-foot and Thirty-foot.
										Hundred-foot	1,440	85		
										Thirty-foot ? .	1,595	40		
										Third....	1,718	20		
										Fourth....	1,770	30		
										Fifth....	1,825	25		
174	Lewis Baker....	....do....	1,150?	Upper Freeport.	125	4	....do....	375	10	Murrysville...	1,300	70	2,775	Dry. A little gas in Fourth sand.
							Lime (block).	412	18	Hundred-foot	1,395	90		
										Third....	1,678	18		
										Fourth....	1,835	40		
										Fifth....	1,938	15		
										Speechley....	2,665	35		
175	John H. Blane....	....do....	1,000	Lower Kittanning.	75	4	Mercer?...	291	19	Hundred-foot	1,140	160	....	Dry hole.
										Third?....	1,360	35		
										Fourth....	1,450	12		
										Fifth....	1,476	31		
176	Bridget McMackin No. 1?	....do....	1,160?	....			Vanport?.	200	20	Hundred-foot	1,190	80	....	Very small gas well.
										Third....	1,540	130		
										Fourth....	1,734	31		
177	L. A. Meals No. 1	....do....	930?	....			Vanport..	205	....	....				
178	....do....	....do....	1,010	Upper Freeport?	65	5	....do....	265	20	Murrysville...	1,170	50	....	Gas in Hundred-foot at 1,384. Rock pressure 400 to 500 pounds.
				Coal?....	285	3	....			Hundred-foot	1,280	108		
										Third....	1,620	44		
										Fourth	1,685	24		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—**Continued.**

NORTH BUFFALO TOWNSHIP—**Continued.**

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
179	James Thompson	Pittsburg Plate Glass Co.	1,100?							Murrysville	1,100	20	1,450	Slight gas at 1,072, 1,104, 1,300, and 1,433.
										Hundred-foot	1,200	105?		
										Third?	1,420	30		
180	Fink No. 2	do	980	Lower Kittanning?	39	3	Limestone.	27	12					
							Vanport?	60	40	Murrysville	969	48	1,017	Gas in Murrysville at 1,017.
181	Jacob Bricker No. 1	G. L. Cabot	1,000				Vanport	80		Third	1,310			
										Fifth	1,535	18	1,563	Gas at 972 and 1,000; gas in Third sand; gas at 1,545.
182	Rayburn heirs No. 1	Carnegie Natural Gas Co.	1,140	Lower Freeport?	145	4	do	360	16	Murrysville	1,245	105	2,740	Gas at 2,685 to 2,710.
										Hundred-foot	1,450	55		
										Fourth	1,740	20		
										Fifth	1,770	80		
										Speechley	2,685	55		
183	Dumbaugh heirs No. 1	do	1,110	Brookville?	464	4	do	385		Hundred-foot	1,375		2,910	Gas in Speechley; minute pressure: 1/55, 2/75, 3/90, 4/105, 5/120; rock pressure 940 pounds.
										Third	1,745	25		
										Fourth	1,830	65		
										Speechley	2,691	25		
184	Geo. M. McCracken	Philadelphia Co.	1,050				Freeport?	32	12	Murrysville	1,277	33	2,790	Gas at 2,625; minute pressure: 1/40, 2/60, 5/120, 10/210, 20/360, 30/460.
										Hundred-foot	1,350	120		
										Third	1,555	25		
										Fourth	1,650	20		
										Fifth	1,727	35		
										Speechley	2,625	43		
185	W. A. Jack No. 1	Pittsburg Plate Glass Co.	1,090	Upper Freeport.	80	4	do	100	18	Murrysville	1,262	5	1,896	

				Upper Kittanning?	165	4	Vanport..	338	20	Hundred-foot	1,340	110?		
										Third?........	1,550	18		
										Fourth?......	1,730	15		
										Fifth.........	1,765	23		
186	John Miller No. 1....	.....do...............	1,180	Upper Freeport.	192	4	....	.....	.....	....	.....	.....		
				Lower Kittanning.	362	4	Vanport..	402	18	Murrysville...	1,374	20	1,840	Gas at 1,384, 1,503, 1,514, and 1,840.
										Hundred-foot	1,402	50		
										Thirty-foot...	1,485	43		
										Fourth?......	1,785	22		
										Fifth.........	1,827	13		
187	S. A. McClelland No. 2.	.....do...............	1,310	Upper Freeport.	265	4	.....do....	515	35	Murrysville...	1,405	65	....	Gas at 1,940.
							Mercer?...	705	15	Hundred-foot	1,490	100		
										Third?........	1,870	22		
										Fourth.......	1,925	35		
188	J. V. Easley No. 1....	.....do...............	1,312	.....do.........	272	.....	Freeport..	280	6	Hundred-foot	1,500	80	1,980	Dry.
							Vanport..	522	25	Third.........	1,892	20		
										Fourth.......	1,942	34		
189	S. A. McClelland No. 1.	.....do...............	1,160	.....do.........	150	.....	....	.....	.....	Murrysville...	1,245	22	1,812	
										Hundred-foot	1,380	80		
										Third.........	1,645	38		
										Fourth	1,692	14		
										Fifth.........	1,783	15		
190	Stonecipher	.....do...............	......	Lower Kittanning?	190	.....	....	.....	.....	....	.....	.....	....	Dry.
191	Samuel Gray No. 1 ...	American Window Glass Co.	1,150	Upper Freeport.	110	4	Freeport..	118	12	....	.....	.....		
				Lower Freeport.	160	5	Vanport..	372	15	Murrysville...	1,280	18	2,791	Gas in Speechley.
				Middle Kittanning?	282	5	....	.....	.....	Hundred-foot	1,366	62		
										Third?........	1,620	46		
										Fifth?........	1,845	5		
										Speechley.....	2,562	23		
192	Calvin Sarver No. 2..	.....do...............	980?	Upper Freeport.	31	5	? Limestone.	115	30	Murrysville...	1,195	20	1,835	
							Vanport..	285	20	Hundred-foot	1,335	72		
							? Limestone.	333	11	Third?........	1,660	29		
										Fourth.......	1,749	20		
										Fifth.........	1,804	5		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

NORTH BUFFALO TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
193	W. J. Bowser	American Window Glass Co.	1,090	Upper Freeport	55	3	Freeport	65	9	Murrysville	1,226	12	1,259	Strong gas in Murrysville.
				Lower Kittanning.	280	4	Vanport	310	20					
194	Margaret Zimmer	do		Upper Freeport.	125	3	Freeport	135	7	Murrysville	1,295	12	2,720	Produces gas.
							Vanport	380	18	Hundred-foot	1,362	125		
										Fourth	1,778	24		
										Fifth	198	5		
										Speechley	2,596	60		
195	J. M. McKee	Pittsburg Plate Glass Co.	998	do	52	3	Freeport	66	16				83	Diamond drill.
196	Sturgeon No. 1	do	960?				•Vanport	175	25				1,475	Abandoned.
197	R. W. Cowan No. 1	J. C. Walley & Co	1,040				do	280	15	Murrysville	1,210	55	1,420	Gas in Hundred-foot at 1,390 to 1,410.
										Hundred-foot	1,278	122		
198	Robert Larden	Pittsburg Plate Glass Co.	920				do	140	20	Murrysville?	1,110	146	1,297	Abandoned.
199	W. C. Reed	do	1,120				do	325	20	Hundred-foot	1,365	55	1,679	Do.
200	W. C. Barnett	do	1,090	Lower Freeport.	721	9							114	Diamond drill.
201	Wm. Cowan No. 1	J. C. Walley & Co					Vanport	320	15	Murrysville	1,240	62	1,487	Strong gas in Hundred-foot at 1,365.
										Hundred-foot	1,335	121		
202	James Bruner	American Window Glass Co.	1,160				Freeport	62	7	Third	1,600	11	1,871	
							Vanport	317	18	Fourth	1,700	30		
										Fifth	1,832	6		
203	Wm. J. Bowser	Wm. J. Bowser								Murrysville	1,241	59		
										Hundred-foot	1,315	80	1,735	
										Third?	1,610	15		

204	David R. Bowser, No. 3.	Apollo Gas Co	1,142	Upper Freeport.	80	3	Vanport..	285	20	Murrysville...	1,200	75	1,607	Gas in Murrysville, Hundred-foot, Thirty-foot and Third? sand.
										Hundred-foot	1,295	60		
										Thirty-foot...	1,440	30		
										Third?........	1,580	22		
205	E. B. Bowser	do	1,180	do	76	6				Murrysville...	1,175	65	1,630	Produces gas; rock pressure 70 pounds.
										Hundred-foot	1,265	60		
										Third?........	1,535	20		
										Fourth?......	1,590	25		
206	Sarah C. Donze	do	1,140							Murrysville...	1,159			Poor record.
										Hundred-foot	1,262			
207	David R. Bowser No.2.	do	1,015	Lower Kittanning?	60	5	Vanport?.	90	25	Murrysville?..	1,044	102	1,405	Produces gas; minute pressure 105 pounds.
										Hundred-foot?	1,190	20		
										Third?........	1,388	17		
208	Geo. Jack	J. C. Walley & Co	1,140				do	335	15	Murrysville...	1,280	50	1,526	Gas at 1,400.
										Hundred-foot	1,385	131		
209	John Gearry	do	1,115				do	305	15	Murrysville...	1,240	60		
										Hundred-foot	1,345	115	1,480	Gas in Hundred-foot at 1,350; minute pressure 40 pounds.
210	Dr. Allison, No. 1	do					do	330	15	Murrysville...	1,208	57	1,480	
										Hundred-foot	1,303	97		
211	T. H. Allison	Pittsburg Plate Glass Co.	1,095	Lower Freeport.	22	1½							106	Diamond drill.

WEST FRANKLIN TOWNSHIP.

212	Jos. Brannen	Pittsburg Plate Glass Co.	1,300				Vanport..	200	22	Murrysville...	1,120	20		Gas at 1,120; abandoned.
										Hundred-foot	1,345	85		
										Third?........	1,500	60		
										Fourth?......	1,568	27		
										Fifth?........	1,630	8		
213	M. E. Smith	do	1,170	Lower Freeport?	30	4	do	213	22	Murrysville...	1,120	40	1,781	Gas in Murrysville; gas in Third sand at 1,515 to 1,575; gas in Fifth sand at 1,675.
										Hundred-foot	1,240	105		
										Third.........	1,515	105		
										Fourth.......	1,625	30		
										Fifth.........	1,670	25		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

WEST FRANKLIN TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
214	J. K. Maxwell No. 3	G. L. Cabot	1,010				Vanport	23	20	Murrysville	965	20	1,515	Produces gas.
										Hundred-foot	1,085	75		
										Third	1,362	30		
										Fourth	1,441	15		
										Fifth	1,486	22		
215	J. K. Maxwell No. 4	do	1,160				do	247	16	Murrysville	1,130	15	1,728	Gas in Hundred-foot at 1,333; gas in Thirty-foot at 1,413; gas in Third at 1,591.
										Hundred-foot	1,225	110		
										Thirty-foot	1,375	45		
										Third	1,584	28		
										Fourth	1,630	10		
										Fifth	1,690	15		
216	J. K. Maxwell No. 2	do	990							Hundred-foot	985	95	1,505	
										Third	1,325	25		
										Fourth	1,360			
										Fifth	1,420			
217	J. K. Maxwell No. 1	do	1,000							Hundred-foot	915	95		Gas in Stray sand at 1,218.
										Stray	1,198			
										Third	1,245	48		
										Fourth	1,342	14		
										Fifth	1,406	28		
218	Peter Graff No. 5	Graff estate	1,015							Murrysville	890	20	1,458	Produces gas.
										Hundred-foot	930	70		
										Third	1,292	48		
										Fourth	1,342	14		
										Fifth	1,390	22		

219	Peter Graff No. 4	do	1,040							Murrysville	915	15	1,407	Gas in Fifth sand.
										Hundred-foot	955	95		
										Third	1,260	40		
										Fourth	1,303	33		
										Fifth	1,373	23		
220	Peter Graff No. 3	do	1,040							Murrysville?	836	15	2,003	
										Hundred-foot	955	100		
										Third	1,255	43		
										Fourth	1,306	18		
										Fifth	1,370	20		Best gas in Fifth sand.
221	Leslie Long No. 1	do	1,125	Upper Freeport	40		Vanport	305	20	Murrysville?	1,200	3	1,680	Poor record; dry.
				Lower Freeport	100					Hundred-foot	1,280	60		
										Third	1,550	23		
										Fourth	158	18		
										Fifth	1,655	23		
222	S. B. Claypool	American Window Glass Co.	1,200	Upper Freeport	130	3	Freeport	137?	28?	Murrysville	1,300	120	2,956	Produces gas.
				Lower Freeport	170	4	Vanport	370	10	Hundred-foot	1,430	110		
										Fourth	1,630	45		
										Fifth?	1,725	100		
										Speechley??	2,340	85		
										Prob. Speechley.	2,644	36		
223	Peter Kerr No. 1	T. W. Phillips	1,250							Hundred-foot	1,450			Gas in Speechley; one of the largest gas wells ever struck.
										Third?	1,700			
										Fifth?	1,800			
										Speechley	2,680			
224	Wm. McCully	Peter Graff & Co.	1,420							Third?	1,445	52	1,497	Produces gas.
225	Riley & McCormick No. 3.?	Pittsburg Plate Glass Co.					Vanport	110	18	Murrysville	1,008	40	1,149	Gas in Murrysville; doubt as to correctness of location.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

SUGAR CREEK TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
226	N. Keener No. 1	Limestone Natural Gas Co.	1,460	Lower Kittanning.	100	4?				Murrysville	1,100	10	1,300	A little gas at 1,105; abandoned.
227	James Crawford	do	1,490	do	100					Murrysville?	1,090		1,100	Strong gas at 1,0[illegible]0; pressure, 250 pounds first minute in casing.
228	S. F. Booher No. 2	do	1,435	do	110	4				do	1,100	10	1,605	Gas in Murrysville, 30 pounds first minute; gas in Fifth sand at 1,565.
										Hundred-foot	1,270			
										Fifth	1,560	40		
229	Thos. A. Foster No. 2	Hunter & Cummings	1,320							Fourth?	1,468	21		
230	Thos. A. Foster No. 1	do	1,340							Third?	1,970	23	1,543?	Produces gas.
										Fourth	1,501	25		
										Fifth	1,533	10		
231	C. W. Foster No. 4	do	1,360							Fourth	1,534	21	1,612?	
										Fifth	1,607	7		
232	James Henry	John Wick, Woll & Co.	1,410	Lower Kittanning.	140	4	Vanport	185		Hundred-foot	1,250		1,618	Gas in Murrysville? at 1,070; gas in Hundred-foot at 1,295.
233	John Patton	United Natural Gas Co.	1,220	do	58	4	do	85	22	do	1,110	105	1,550	Produces gas.
										Third	1,345	9		
										Fourth	1,443	20		
234	Scott Hepler	do	1,290	do	140	4	do	185	18	Hundred-foot	1,170		2,451	Gas in Speechley at 2,420.
										Third	1,420			
										Fourth	1,526			
										Speechley	2,410	10	1,708	Produces gas
235	Atkinson	do	1,310				do	280	5	Hundred-foot?	1,230	72		

										Third?	1,572	7		
236	John Adams No. 1	Hunter & Cummings.	1,295	Lower Kittanning?	215		do	285	16	Murrysville	1,114	20	2,525	Do.
										Hundred-foot	1,295	90		
										Third	1,546	10		
										Fourth	1,604	12		
										Speechley	2,446	18		
237	Pontius No. 7	Westermann Bros.	1,345				do	380	18	Third	1,596	45	1,641?	Produces oil.
238	Pontius No. 6	Hunter & Cummings.	1,370				do	400	18	do	1,628	47	1,675?	Do.
239	Pontius No. 9	Westermann Bros.	1,320				do	336	18	do	1,546	43	1,589?	Do.
240	Pontius No. 8	Hunter & Cummings.	1,370				do	415	18	do	1,643	39	1,582	Do.
241	Pontius No. 11	do	1,380				do	420	20	do	1,628	61	1,768	Do.
										Fourth	1,703	15		Gas at 1,745.
										Fifth	1,743	25?		
242	Michael McCray No. 5	do	1,270	Upper Freeport.	30	6	do	260	38	Murrysville	1,068	2	1,490?	Produces oil.
										Hundred-foot	1,232	30		
										Stray	1,480	10		
243	I. Reep	Westermann Bros.	1,320							Fourth	1,647	15	1,662?	Do.

BRADY'S BEND TOWNSHIP.

244	Sauerkraut No. 1	Seybert Bros.	1,350							Hundred-foot	1,316		1,583	Produces oil.
										Third	1,561	22		
245	Amos Steele	American Window Glass Co.	1,360	Upper Freeport.	100	5	Vanport	360	20	Hundred-foot	1,420	85	2,573	
				Middle Kittanning.	280	5				Third	1,578	22		
				Lower Kittanning.	320	4				Fourth	1,669	6		
										Speechley?	2,531	25		
246	Mary & G. W. Kepple No. 1.	Philadelphia Co.	1,380?	Upper Freeport.	100	3	Vanport	353	19	Murrysville	1,200	20	3,202	Abandoned.
				Upper Kittanning.	235	2				Hundred-foot	1,295	105		
				Lower Kittanning.	310	3½				Third	1,570	15		
										Fourth	1,635	10		
										Speechley	2,522	14		
										Tiona?	2,710	35		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

BRADYS BEND TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
247	Bradys Bend Iron Co. No. 4.	Bradys Bend Iron Co.	840?							Third	965	[illegible]	1,260	Produced oil.
										Fourth	998	17		
248	Bradys Bend Iron Co. No. 5.	do	852							Hundred-foot?	715	20	1,100	Do.
										Third	1,026	24		
										Fourth	1,075	25		

EAST FRANKLIN TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams: Name.	Depth.	Thickness.	Limestones: Name.	Depth.	Thickness.	Oil and gas sands: Name.	Depth.	Thickness.	Total depth of well.	Product.
249	David C. Bowser	Apollo Gas Co	1,025				Vanport?	125		Third	1,440			Light gas at 1,060 to 1,155; gas in Third sand.
250	Thos. Hays No. 3	do	1,150				Vanport	245	37	Murrysville	1,146	100	1,563?	Gas in Murrysville and Third sands.
										Hundred-foot	1,275	96		
										Third	1,535	25		
251	Thos. Hays No. 2	do	1,140				do	291	15	Murrysville	1,210	26		Gas in Third sand.
										Hundred-foot	1,305	40		
										Third	1,582	53		
252	David R. Bowser No. 1	do	1,090				do	160	25	Murrysville	1,075	15	1,470?	Gas in top of Third sand; rock pressure 550 pounds.
										Hundred-foot	1,140	111		
										Third	1,455	15		
253	Thos. Hays No. 1	do	1,160	Lower Freeport?	91	3	do	281	31	Murrysville	1,190	40	1,892	Gas in Hundred-foot and Third sands; abandoned.
										Hundred-foot	1,230	144		
										Third	1,578	38		
										Fourth	1,680	30		
										Fifth	1,760	12		

254	Thos. Hays No. 4	do	1,000							Murrysville	948	106		Gas in Murrysville and Third sands.
										Hundred-foot	1,060	90		
										Third	1,368	71		
255	Ellermeyer No. 1	Manufacturers' Natural Gas Co.	1,160	Lower Freeport	40	4	Vanport	290	25	Murrysville	1,162	27		Gas in Murrysville and Hundred-foot and Thirty-foot sands; little gas in Burgoon sand.
				Middle Kittanning?	200	4				Hundred-foot	1,200	20		
										Thirty-foot	1,290	50		
										Third?	1,562	26		
256	James Wible No. 1	Kittanning Iron and Steel Co.	1,133				do	290	20	Murrysville	1,125	25	1,153	Produces gas.
257	Blair	do	1,100	Upper Freeport	90		do	325						Do.
258	J. B. Drake	Pittsburg Plate Glass Co.	1,185	do	22	3¾							247	Diamond drill.
				Lower Freeport	77	4								
				Upper Kittanning	112	2¾								
				Middle Kittanning	176	2 1/12								
				Lower Kittanning	235	3½								
259	W. P. Bowser	do	1,285	Upper Freeport	210	1½							264	Do.
				Lower Freeport	257	3½								
260	J. H. Guthrie	do	1,080	Middle Kittanning?	155	3				Murrysville	1,165	25	1,652	
				Lower Kittanning	205	4				Hundred-foot	1,260	25		Dry.
										Third?	1,605	25		
261	J. A. Patton	Local company	1,180	Lower Freeport	60		Freeport	30	15	Hundred-foot	1,275	25	2,402	Dry; supposed to be drilled to Speechley sand at 2,230.
				Lower Kittanning.	235	6				Third?	1,525	25		
										Fourth?	1,620	20		
										Fifth?	1,620	20		
										? sand	2,230	60		
262	Allegheny Furnace No. 3.	Kittanning Iron and Steel Co.	875							Murrysville	780	20	1,253	Gas at 780.
										Hundred-foot?	885	55		
										Speechley	2,194	47		
263	Arnold No. 5	do	800							Murrysville?	635	175	1,288	Gas at 786 and above.
										Hundred-foot?	825	75		
										Thirty-foot	915	95		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

EAST FRANKLIN TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
264	McGinnis	Limestone Natural Gas Co.	880							Murrysville	800	45	1,504	Gas in Murrysville at 805 and 855; show of gas at 1,280; rock pressure 140 pounds.
										Hundred-foot	885	90		
										Third	1,140	20		
										Fourth?	1,230	10		
										Fifth?	1,280	5		
265	Arnold No. 4	Kittanning Iron and Steel Co.	820							Murrysville	705	20	2,266	A little gas in Murrysville, Hundred-foot, and Fourth sands.
										Hundred-foot	803	67		
										Third? sand	1,060	35		
										Fourth	1,220	25		
266	Arnold No. 3	do	890							Murrysville	830	20	971	A little gas in Murrysville and strong gas in Hundred-foot.
										Hundred-foot	915	35		
267	Arnold No. 2	do	830							Murrysville	766	25	861	Gas in Murrysville at 766 to 776, and in Hundred-foot; pressure 76 pounds.
										Hundred-foot?	836	25		
268	Richardson No. 1	do	880							Hundred-foot	950	15	1,254	Dry.
										Third?	1,155	55		
269	W. R. Lemon	do	880							Hundred-foot	880	75	1,110	Gas in Hundred-foot between 880 and 905, at 925, and in Thirty-foot.
										Thirty-foot	965	25		
270	A. B. Wyant No. 1	Limestone Natural Gas Co.	1,160	Lower Kittanning.	190	4	Vanport	235	18	Murrysville	1,100	10	1,745	A little gas at 1,100.
										Hundred-foot	1,230	50		
										Third	1,575	20		
										Fourth	1,635			

271	H. E. Zellifrow	Apollo Gas Co.	1,160	do	175	.....	Vanport	190?	.....	Hundred-foot	1,207	......	1,515	
										Third	1,470			
										Fourth	1,515			
272	Geo. McCracken No. 1.	Pittsburg Plate Glass Co.	1,130	do	170	4				Murrysville	1,002	15	1,530	Dry; Murrysville in three benches; a little gas in upper and lower benches.
										do	1,027	77		
										do	1,122	34		
										Hundred-foot	1,175	110		
										Fourth	1,520	8		
273	James Toy	Apollo Gas Co.	1,320	Upper Freeport.	110	4				Murrysville	1,197	10	1,345	Light gas at 1,032; strong gas at 1,272.
										do	1,222	30		
										do	1,272	10		
274	J. B. Neal	Philadelphia Co		do	55	4	Vanport	310	8	Hundred-foot	1,250	65	2,800	Produces gas.
				Upper Kittanning.	140	2				Third	1,575	33		
				Lower Kittanning.	269	3				Fourth	1,630	5		
										Fifth?	1,775	10		
										Speechley?	2,444	8		
										do	2,550	70		
										Tiona?	2,635	15		
275	Riley & McCormick No. 2.	Pittsburg Plate Glass Co.	1,450				Vanport	140	15	Murrysville	1,032	42	1,079	Gas at 1,032 to 1,037 and 1,042 to 1,054.
276	Elder	Limestone Natural Gas Co.	810							do	740	25	880	Gas in Murrysville at 740 and 785, and in Hundred-foot at 860; rock pressure 135 pounds.
										do	773	35		
										Hundred-foot?	828	52		
277	D. D. Quigley	Reese Bros	850							Murrysville	795	27	928	Gas in Murrysville at 803, in Hundred-foot at 895 and 928; rock pressure 130 pounds.
										do	830	25		
										Hundred-foot?	875	53		
278	Mateer	Limestone Natural Gas Co.	1,000							Murrysville?	940	35	1,358	Gas at 900; light gas at 945, 1,165, and 1,332.
										do	985	15		
										Hundred-foot	1,020	20		
										Third	1,330	8		
279	Hooks	do	810							Murrysville	810	92	......	Gas at 728, 810, and 855. Rock pressure 155 pounds.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

EAST FRANKLIN TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
280	Patton	Limestone Natural Gas Co.	810							Murrysville	810	30	1,344	Gas at 875, 1,010, and 1,310.
										do	865	25		
										Hundred-foot	910	50		
										Third?	1,120	10		
										Fourth?	1,180	15		
										Fifth	1,302	20		

WASHINGTON TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
282	Dickey No. 1	Limestone Natural Gas Co.	810							Murrysville	715	20	900	Gas at 720, 810, and 870; rock pressure, 155 pounds.
										do	800	40		
										Hundred-foot	860	40		
281	Dickey No. 2	do	810							Murrysville	695	55	895	Gas at 815 and 861 to 881; rock pressure, 155 pounds; dry well.
										do	775	10		
										Hundred-foot	861	20		
283	Myers	Apollo Gas Co	1,250	Upper Kittanning?	140	3	Vanport	259	15	Murrysville	1,154	56	1,396	Produces gas.
				Lower Kittanning?	235	4				Hundred-foot	1,225	75		
284	Miller Bowser	do	1,360	Upper Kittanning?	240	5				Murrysville	1,225	74	1,380	Do.
										Hundred-foot	1,340	20		
285	Wm. Johns	do	1,260	Lower Freeport.	75	3	Freeport	11	12	Murrysville	1,080	40	1,175	Gas at 1,170.
				Middle Kittanning?	166	4	Vanport	244	8	do	1,140	30		

286	Montgomery No. 4	Limestone Natural Gas Co.	990				do	40		do	925		1,600	Gas at 1,120 and 1,425.
										do	955			
										Hundred-foot	1,020			
287	Abraham Chrisman	Apollo Gas Co	1,310	Lower Freeport.	60	3	do	260	5	Murrysville	1,160	45	1,806	Gas in Murrysville
				Lower Kittanning.	230	4				Hundred-foot	1,276	59		
										Fourth?	1,605	60		
288	J. A. Colwell	do	810							Murrysville	610	50		Dry.
										Hundred-foot	833	143		
										Fourth?	1,132	38		
										Speechley	2,000	18		
										Tiona	2,175	55		
289	W. E. Titley	Limestone Natural Gas Co.	1,320	Middle Kittanning.	16					Murrysville	995		1,588	Do.
										Hundred-foot	1,150			
290	Thos. Templeton No. 1	Pittsburg Plate Glass Co.	1,240				Vanport	16	18?	Murrysville	944	34		
										Hundred-foot	1,037	99	1,514	

MANOR TOWNSHIP.

291	J. A. Logan	Philadelphia Co	1,050	Lower Freeport?	244	4				Murrysville	1,282	78	1,522	Gas in Murrysville at 1,341; minute pressure: 1/185, 2/290, 3/420; rock pressure, 500 pounds.
				Lower Kittanning?	360	3				Hundred-foot?	1,382	108		
292	T. Heilman	Pittsburg Plate Glass Co.	1,050				Vanport	326?	11	Murrysville?	1,320	35	2,036	Dry.
										Hundred-foot?	1,475	30		
293	John Heilman	do	985	Lower Kittanning.	225	5	Freeport	63	22	Murrysville	1,190		1,217	Gas at 1,192.
							Vanport	244	18					
294	Chas. Heilman No. 1	do	980	Lower Freeport.	125	5	Freeport	70	20	Hundred-foot	1,188		1,208	Gas at 1,188.
							Vanport	290	20					
295	Robert Heilman	Philadelphia Co	960				Freeport	26		Murrysville	1,196	79	1,420	Minute pressure: 1/120, 2/175, 5/220, 10/235; rock pressure, 250 pounds.
							Vanport	310?		Hundred-foot	1,290	85		
										Thirty-foot	1,393	10		
296	J. R. Christy	do	945								1,223			Minute pressure ½/200, 1/280, 2/325, 4/340, 10/345; rock pressure, 400 pounds.
297	Montgomery No. 1	Pittsburg Plate Glass Co.	965				Vanport	310	15	Murrysville	1,205	10	1,215	Gas at 1,215.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—**Continued.**

MANOR TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet		Feet.	Feet.		Feet.	Feet.	Feet.	
298	Montgomery No. 3	Pittsburg Plate Glass Co.	950	.....	.....	.....	Vanport	305	20	Murrysville	1,200	90	.....	Gas at 1,228 and 1,325.
										Hundred-foot	1,295	95		
299	Montgomery No. 2	....do	1,000	Lower Kittanning.	296	4	Freeport	94	30	Murrysville	1,231	.....	1,240	Gas at 1,231.
							Vanport	334	15	.....	.....	.....		
300	Thos. Smith	Philadelphia Co	1,000	Upper Kittanning?	205	4	.....	.....	.....	Murrysville	1,230	90	2,035	Gas at 1,450; minute pressure: 1/65, 2/115, 5/210, 10/280, 20/315.
				Brookville?	380	3	.....	.....	.....	Hundred-foot	1,340	100		
										Thirty-foot	1,450	21		
301	J. and T. Heilman	....do	1,010	.....	.....	.....	.....	.....	.....	Murrysville	1,222	56	.....	Produces gas.
										Hundred-foot	1,293	84		
										Thirty-foot	1,410	28		
302	Geo. Aye	(?)	1,010	Lower Freeport.	120	6	Freeport	95	15	Murrysville	1,254	95	1,335	Produces gas; minute pressure: 1/74.
				Brookville?	470	7	Vanport	350	20	Hundred-foot	1,369	60		
303	Crytzer well	Pittsburg Plate Glass Co.	1,140	Upper Freeport.	175	6	Freeport	185	12	Murrysville	1,240	20	1,320	Gas below 1,290.
							Vanport	375	12	....do	1,290	30		
304	Jacob Hobaugh No. 2.	Ford China Co	970	.....	.....	.....	Freeport	15	57	....do	1,150	72	1,397	Produces gas.
										Hundred-foot	1,300	.....		
305	Jacob Hobaugh No. 1.	....do	920	Lower Kittanning.	115	5	.....	.....	.....	Murrysville	1,073	70	.....	Gas at 1,103 and 1,175.
306	Cronin No. 2	....do	950	.....	.....	.....	Vanport	125	.....	....do	1,090	82	1,205	Heavy gas at 1,184 to 1,205.
										Hundred-foot	1,157	48		
307	Rupert No. 1	Pittsburg Plate Glass Co.	820	.....	.....	.....	.....	.....	.....	Murrysville	.....	.....	1,315	Gas at 1,190 and 1,240; record probably unreliable.
										Hundred-foot	1,026	249		

RAYBURN TOWNSHIP.

308	McNees & Painter....	Kittanning Clay Manufacturing Co.	850	....	....	....	Vanport..	40	10	Murrysville...	930	20	1,228	A little gas at 980.
							Mercer?...	225	15	....do........	980	5		
										Hundred-foot	1,015	80		
309	A. Starr No. 1........	Kittanning Plate Glass Co.	1,240	....	....	....	Vanport..	300	.....	Murrysville...	1,283	......	1,503	Produces gas.
310	A. Starr No. 2........	....do...............	1,240	....	....	....	....do....	30	.....	....do........	1,288	......	1,901	Gas at 1,288.

KITTANNING TOWNSHIP.

311	C. Heilman No. 1.....	Pittsburg Plate Glass Co.	1,260	Upper Freeport.	80	5	Freeport..	400	13	Murrysville...	1,255	75	1,944	Gas in 30 feet.
										Hundred-foot	1,340	95		
										Thirty-foot...	1,450	30		
										Fourth?......	1,670	10		
										Fifth.........	1,855	56		
312	C. Heilman No. 2.....	....do...............	1,360	....do.........	226	5	....	.....	.....	Murrysville...	1,360	80	80	Produces gas.
										Hundred-foot	1,950	100		
										Thirty-foot...	1,560	30		
										Fifth?........	1,960	55		
313	Peter Heilman No. 2..	(?)	1,260	Upper Kittanning?	110	3	Limestone?	123	7	Murrysville...	1,166	64	1,970	Do.
				Lower Kittanning.	225	4	Vanport..	260	10	Hundred-foot	1,275	40		
										Fifth.........	1,798	20		
314	John Schaffer No. 2...	Pittsburg Plate Glass Co.	1,300	....	....	....	....do....	370	15	Murrysville...	1,225	27	1,252	Gas in Murrysville.
315	Geo. L. Blose.........	Philadelphia Co......	1,200	Lower Kittanning?	220	....	....	.....	.....	....do........	1,185	105	1,857	Gas at 1,210, 1,323, and 1,849.
										Hundred-foot	1,295	120		
										Fifth?........	1,844	13		
316	McElroy...............	....do...............	1,350	Upper Freeport.	70	3	....	.....	.....	Murrysville...	1,215	55	1,926	Gas at 1,215; minute pressure: 1/20, 2/30, 3/58, 10/53; rock pressure, 73 pounds.
				Lower Kittanning?	275	3	....	.....	.....	Hundred-foot	1,295	135		
										Fifth?........	1,877	16		
317	Sarah Everhart.......	....do...............	1,225	....	....	....	....	.....	.....	Murrysville...	1,160	68	3,014	Produces gas.
										Hundred-foot	1,238	117		
										Speechley.....	2,560	40		
										Tiona........	2,700	20		
										....do........	2,740	50		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

KITTANNING TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
318	Margaret Wallace....	Philadelphia Co......	1,300	Upper Freeport.	80	4?	....	.....	.....	Murrysville...	1,180	105	2,863	
										Hundred-foot	1,295	125		
										Fifth.........	1,830	38		
										Speechley.....	2,633	27		
										Tiona.........	2,750	12		
										.....do........	2,772	76		
319	G. S. Rohrer..........	.....do................	1,230	.....do..........	80	4?	....	.....	.....	Murrysville...	1,230	35	2,905	
										Hundred-foot	1,280	150		
										Thirty-foot...	1,455	15		
										Fifth.........	1,820	10		
										Speechley.....	2,630	30		
										Tiona.........	2,800	60		
320	Jos. H. Sowers No. 2..	Pittsburg Plate Glass Co.	1,470	....	.....	.....	Freeport..	207	15	Murrysville...	1,330	50	1,548	Produces gas.
							Vanport..	437	8	....	......	......		
321	Collum No. 1.........	Manufacturers' Natural Gas Co.	1,470	Upper Freeport.	100	4	Freeport..	104	8	Murrysville...	1,269	60	1,924	Gas in Murrysville, Hundred-foot, Thirty-foot, and Fifth.
				Lower Kittanning.	295	5	Vanport..	295	5	.....do........	1,345	55		
										Thirty-foot...	1,430	75		
										Fifth.........	(?)	(?)		
322	Moorehead No. 1......	.....do................	1,480	....	.....	.....	Freeport..	30	10	Murrysville...	1,231	47	1,498	Gas in Murrysville.
										Hundred-foot	1,288	100		
										Murrysville...	1,050	20	....	Light gas in Murrysville, strong gas in Thirty-foot.
323	Shelton No. 3.........	.....do................	1,360	....	.....	.....	....	.....	.....	Hundred-foot	1,157	58		
										Thirty-foot...	1,340	75	1,455	

324	Sullivan No. 1	Manufacturers' Natural Gas Co.	1,470	Upper Freeport	185	2	Vanport	360	7	Murrysville	1,288	33	1,529	Light gas in Murrysville.
										Hundred-foot	1,357	40		
										Thirty-foot	1,475	46		
325	Shelton No. 1	do	1,500				do	340	10	Murrysville	1,260	40	1,533	Gas in top and bottom of Murrysville.
										Hundred-foot	1,325	100		
326	Goldstrom No. 2	do	1,300				do	140	10	Murrysville	1,022	30	1,410	Gas in top of Murrysville; main gas in Thirty-foot.
										Hundred-foot	1,078	102		
										Thirty-foot	1,193	107		
327	Gitel No. 1	do	1,410				do	272	12	Murrysville	1,150	50	1,867	Gas in top and bottom of Murrysville.
										Hundred-foot	1,225	106		
										Thirty-foot	1,[illegible]50	119		
										Fifth	1,770	15		
328	Cravener No. 1	Pittsburg Plate Glass Co.	1,160				do	10	7	Murrysville	880	105	1,618	Gas at 890, 1,125, and 1,203.
										Hundred-foot	988	154		
										Thirty-foot	1,166	49		
329	B. S. Cook	Philadelphia Co	1,480							Murrysville	1,323			Produces gas.
										Hundred-foot	1,455			
330	L. Smith No. 2	Eastern Oil Co	1,410	Upper Freeport	108		Freeport	130		Murrysville	1,250	68	1,447?	Gas at 1,265 and 1,430.
										Hundred-foot	1,360	87		
331	J. Rosenberger	do	1,440	do	105		do	125		Murrysville	1,252		1,445	Gas in Murrysville at 1,255 and 1,278; in Hundred-foot at 1,422 and 1,432.
										Hundred-foot	1,344			

VALLEY TOWNSHIP.

332	Goldstrom No. 1	Manufacturers' Natural Gas Co.	1,120							Murrysville	913	31	1,126	Gas in top and bottom of Murrysville in Hundred-foot and in Thirty-foot so strong as nearly to blow tools from hole.
										Hundred-foot	959	119		
										Thirty-foot	1,114	12		
333	Bishoff No. 1	do	1,300				Vanport	165	8	Murrysville	1,072	30	1,291	Gas in Murrysville and Hundred-foot.
										Hundred-foot	1,122	169		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—**Continued.**

VALLEY TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
334	Shelton No. 2	Manufacturers' Natural Gas Co.	1,100							Murrysville	855	35	1,533	Gas in top and bottom of Murrysville.
										Hundred-foot	915	135		
										Thirty-foot	1,060	58		
										Fourth?	1,400	40		
										Fifth?	1,508	15		
335	Turney No. 1?	Pittsburg Plate Glass Co.	1,090?							Murrysville	820?	45	1,505	Gas at 893, 912, and 920.
										Hundred-foot	893	97		
										Thirty-foot?	1,030	145		
										Fifth?	1,470	10		
336	J. J. McAfee No. 2	People's Natural Gas Co.	1,005							Murrysville	885	35	1,568	Gas at 920 to 1,070.
										Hundred-foot	960	65		
										Fifth?	1,496	19		
337	J. J. McAfee No. 1	Pittsburg Plate Glass Co.	980							Murrysville	890	30	1,600	Light gas in Murrysville and in Hundred-foot at 995.
										Hundred-foot	980	80		
										Fourth?	1,435	20		
338	Henry Bear	Eastern Oil Co	1,230							Murrysville	990		1,204	Gas at 990 and 1,114 light.
										Hundred-foot	1,109			
339	James Hawkins	do	1,430							Murrysville	1,153	93?	1,385	Gas at 1,153, 1,158, and 1,360.
										Hundred-foot	1,256	129?		
340	Jno. McIlwain No. 1	People's Natural Gas Co.	1,340							Murrysville	995	70	1,289	Gas at 1,065, 1,080, 1,130, and 1,275.
										Hundred-foot	1,165	124		
341	J. N. Southworth?	Eastern Oil Co	1,360	Lower Kittanning.	158					Murrysville	1,121	17?	1,351	Produces gas 600,000 feet in 24 hours.
										Hundred-foot	1,237	13		

342	J. Sinclair No. 2	do	1,440				Vanport	420?		Murrysville	1,165	70	1,309	Gas at 1,165, 15 pounds; gas at 1,280, 34 pounds.
										Hundred-foot	1,340	66		
343	James Adams	Greenbaum, Runyan & Co.	1,340							Murrysville	1,083		1,358	Dry.
										Hundred-foot	1,180			
344	Peter Schreckengost	Eastern Oil Co	1,400							Murrysville	1,121		1,352	Gas at 1,151, 1,228, and 1,282; pressure in 10 minutes, 100 pounds.
										Hundred-foot	1,228	54		
345	J. Zimmerman	do	1,280				Vanport	105		Murrysville	990	100	1,224	Gas at 995 and 1,025.
										Hundred-foot	1,110	85		
346	Samuel Runyan	do	1,560				do	314		Murrysville	1,240	91	1,478	Gas at 1,247 and 1,360.
										Hundred-foot	1,348	63		
										Thirty-foot	1,417	10		
347	E. C. & J. E. McIlwain.	People's Natural Gas Co.	1,380							Murrysville	1,080	45	1,230	Gas at 1,200 to 1,230.
										Hundred-foot	1,200			
348	R. R. Barker No. 2	Eastern Oil Co	1,430							Murrysville	1,156	81	1,364	Gas at 1,156, 1,262, and 1,284.
										Hundred-foot	1,246	104		
349	B. Nulton	do	1,300				Vanport	90		Murrysville	1,010	80	1,268	Gas at 1,110.
										Hundred-foot	1,110	80		
350	E. C. & J. E. McIlwain.	People's Natural Gas Co.	1,200				do	40	8	Murrysville	865	30	1,140	Gas at 865.
										Hundred-foot	925	30		
351	Wm. Brunt	Philadelphia Co	1,250	Lower Freeport	143	3?				Murrysville	1,250	82	2,981	Produces gas.
										Hundred-foot	1,342	108		
										Speechley	2,665	19		
352	Thos. N. Bowser No. 1	do	1,260	Upper Kittanning.	218	4?				Murrysville	1,275	80	1,501	Do.
										Hundred-foot	1,385	60		
										Thirty-foot	1,475	23		
353	Daniel Slagle	Eastern Oil Co	1,355				Vanport	330		Murrysville	1,260	95	1,528	Gas at 1,270 and 1,345.
										Hundred-foot	1,375	80		
										Thirty-foot	1,468	17		
354	Thos. N. Bowser No. 2	Philadelphia Co	1,300	Upper Freeport	100	3?				Murrysville	1,269	98	1,531	Produces gas.
				Upper Kittanning.	204	4?				Hundred-foot	1,377	63		
										Thirty-foot	1,459	41		
355	Homer Rhodes No. 2.	Kittanning Plate Glass Co.	1,280							Murrysville	1,238		1,262	Gas in top of Murrysville.
356	John Rhodes	Philadelphia Co	1,210	Upper Freeport	95	3?				do	1,164	77		Produces gas.

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

VALLEY TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
357	Mosgrove No. 2	People's Natural Gas Co.	1,010				Vanport	24	8	do	875	65	1,133	Gas at 875 and 1,080.
										Hundred-foot	900	100		
										Thirty-foot	1,075			
358	H. S. Slease No. 3	Pittsburg Plate Glass Co.	1,150	Lower Kittanning?.	160	4	do	180	10	Murrysville	1,036	40	1,093	Gas at 1,040.
359	Mosgrove No. 1	People's Natural Gas Co.	1,020							do	890	10	900	Gas at 890.

BOGGS TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
360	Peart No. 2	Pittsburg Plate Glass Co.	1,070							Murrysville	750	130	1,463	Gas at 750.
										Hundred-foot	940	40		
										Fourth?	1,284	12		
										Fifth?	1,350	25		
361	J. & F. Powers?	Philadelphia Co.	1,060	Brookville?	60	2				Murrysville	787	117	2,305	A little gas in top of Hundred-foot.
										Hundred-foot	925	90		
										Fifth	1,405	10		
										Speechley	2,185	31		
362	Mosgrove No. 2	People's Natural Gas Co.	1,080				Vanport	90		Murrysville	900	115	1,130	Gas at 905 and 1,105.
363	John Moore	Greenbaum, Runyan & Co.	1,220	Mercer?	128	4?				do	822		850	Produces gas.
364	John Dill No. 1	People's Natural Gas Co.	1,340							do	840	70	2,270	Gas at 2,254.
										Hundred-foot	920	95		
										Fifth	1,440	15		

										Speechley?	2,178	40		
										do	2,243	17		
365	Robt. Martin No. 1	do	1,270	Lower Kittanning.	80	4				Murrysville	940	45	1,286	Dry.
										Hundred-foot	1,050	50		
366	David Dever No. 1	do	1,225?				Freeport	25	10	Murrysville	1,045	75	2,800	Gas at 1,050 and 1,185.
										Hundred-foot	1,140	20		
										Fourth	1,600	15		
										Speechley	2,525	50		
367	J. E. B. Mateer No. 2?	do	1,280				Vanport	225	8	Murrysville	1,065	45	1,370	Gas at 1,065, 1,105, 1,125 and 1,275.
										Hundred-foot	1,125	20		
										Thirty-foot	1,270	45		
368	David Dever No. 4	do	1,290							Murrysville	1,140	40	1,460	Gas at 1,140 and 1,250.
										Hundred-foot	1,250	75		
369	J. M. McCullough No. 1.						Vanport	40		Murrysville	895	45	1,232	Gas at 895, 1,060, and 1,158.
										Hundred-foot	1,060	30		
										Thirty-foot	1,120	38		
370	J. E. B. Mateer No. 3	People's Natural Gas Co.	1,100	Clarion	190					Murrysville	1,050	15	1,268	Dry.
										Hundred-foot	1,090	40		
371	L. B. Bowser No. 2	do	1,010							Murrysville	870	50	1,109	
										Hundred-foot	930	115		
372	John Upperman No. 1	do	1,030				Vanport	20	20	Murrysville	880	20	1,092	Produces gas at 1,060 to 1,092.
										Hundred-foot	920	110		
										Thirty-foot	1,060			
373	Hugh and Sarah Heffelfinger.	do	1,050							Murrysville	857	73	1,087	Gas at 915 and 1,055.
										Hundred-foot	963	92		
374	J. E. B. Mateer No. 1?	do	1,200?	Upper Kittanning?	100	4				Murrysville	1,110	50	1,329	Gas at 1,110, 1,180, and 1,305.
				Lower Kittanning?	210	4				Hundred-foot	1,175	105		
										Thirty-foot	1,300			
375	J. W. Baum	do	1,070							Murrysville	830	70	2,315	Produces gas.
										Hundred-foot	930	30		
										Thirty-foot	1,010	5		
										Speechley	2,220	22		
376	L. Bowser No. 1	do	1,170							Murrysville	800		2,565	Gas at 830 and 2,200.
										Speechley	2,200	35		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—**Continued.**

BOGGS TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
377	A. Heffelfinger No. 2	Apollo Gas Co.	1,200	Brookville?	80	4				Murrysville	850	15	868	
378	Frank B. Martin No. 1	People's Natural Gas Co.	1,170	do.?	60	6?				do.	817	15	832	Gas at 817 to 832.
379	Wm. Martin No. 1	do.	1,160							do.	1,070	25	1,396	Gas at 1,070, 1,230, and 1,270.
										Hundred-foot	1,200	50		
										Thirty-foot	1,270	50		
380	Frank B. Martin No. 2	do.	1,190							Murrysville	754	18	772	Gas at 754.
381	Mrs. Rumbaugh No. 1	do.	1,215							do.	750	45	847	Gas at 750.
										Hundred-foot	815	32?		
382	J. A. White No. 1	Apollo Gas Co.	1,260?							Murrysville	770	50	900	Gas in Murrysville.
										Hundred-foot	840	25		
383	Wm. Martin No. 2	do.	1,440?	Lower Kittanning.	185		Vanport	212		Murrysville	1,060	65	2,648	Strong gas in Tiona sand.
										Hundred-foot	1,140	100		
										Thirty-foot	1,255	30		
										Speechley	2,440	60		
										Tiona	2,625	23		
384	Geo. W. Sowers No. 1	People's Natural Gas Co.	1,470	Upper Freeport	80	4	do.	303	6	Murrysville	1,060		1,076	Gas at 1,060.
385	D. C. White No. 1	do.	1,550	Upper Kittanning?	180		do.	320		do.	1,160	90	1,370	Gas at 1,160, 1,250, and 1,335.
										Hundred-foot	1,260	75		
386	Jackson Zimmerman	do.	1,270				do.	217	8	Murrysville	1,050	50	1,317	Gas at 1,050 and 1,110.
										Hundred-foot	1,110	175		
387	Benj. Evans No. 1	Apollo Gas Co.	1,325				do.	180	9	Murrysville	1,000	32	1,037	Gas in Murrysville.
388	Benj. Evans No. 2	do.	1,385				do.	200	10	do.	1,030	18	1,058	Do.

389	David Dever No. 2...	People's Natural Gas Co.	1,300?	....			Freeport..	120	5	.....do........	1,040	25	1,395	Dry.
										Hundred-foot	1,180	......		
										Thirty-foot...	1,308	37		
390	David Dever No. 3...	.....do..............	1,370	Upper Freeport	30	4	....			Murrysville...	1,100	80	1,385	Gas at 1,100 and 1,285.
										Hundred-foot	1,219	90		
										Thirty-foot...	1,320	20		
391	J. A. White..........	Goheenville Gas Co...	1,100	....			Vanport..	20	....	Murrysville...	870?	25	1,030	Gas at 955; increasing downward.
										Hundred-foot	950	80		
392	J. P. Kammerdiener..	Apollo Gas Co........	1,150	Lower Kittanning.	35	4	.....do....	70	8	Murrysville...	917	18	....	Gas in Murrysville.
										Hundred-foot	987	70		
										Thirty-foot...	1,095	60		
393	Henry Houser heirs..	.....do..............	1,340	.....do..........	260	4	.....do....	300	8	Murrysville...	1,140	25	1,771	Do.
										Hundred-foot	1,180	70		
										Thirty-foot...	1,260	90		
										Third?........	1,600	10		
										Fourth.......	1,670	15		
394	Robert McAfoose.....	.....do..............	1,030	....			.....do....	40	8	Murrysville...	884	15	907	Do.
395	W. H. Kuhns.........	.....do..............	1,080	Clarion.........	90	2	.....do....	40	15	.....do........	890	25	1,560	Do.
										.....do........	935	40		
										Hundred-foot	975	100		
										Thirty-foot...	1,085	60		
										Fourth?......	1,346	36		
										Fifth?........	1,530	15		
396	J. M. Halderman.....	.....do..............	1,280	Upper Freeport.	40	3	.....do....	285	8	Murrysville...	1,127	50	2,804	Dry; a little gas in Murrysville.
										Hundred-foot	1,187	40		
										.....do........	1,257	25		
										Thirty-foot...	1,322	85		
										Third?........	1,602	10		
										Fourth?......	1,687	10		
										Speechley.....	2,527	35		
397	John Brosius No. 2?..	.....do..............	1,330	Lower Freeport?	94	5	Freeport..	70	4	Murrysville...	1,180	12	1,767	Gas in Murrysville.
				Lower Kittanning?	289	4	Vanport..	330	9	Hundred-foot	1,247	45		
										Thirty-foot...	1,300	115		
										Fourth.......	1,725	20		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—**Continued.**

BOGGS TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
398	John Brosius No. 1	Apollo Gas Co	1,330	Lower Freeport?	90	4	Freeport	64	6	Murrysville	1,165	55	1,310	Gas at 1,298; minute pressure: 1/130, 2/200, 5/270; rock pressure 350 pounds.
										Hundred-foot	1,250	100		

MADISON TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
399	O. Gray No. 1	Apollo Gas Co	1,320?				Vanport	48	12	Murrysville	896	17	1,615	A little gas in Murrysville. Gas in Fourth, 15 pounds per minute; 300 pounds rock pressure.
										Hundred-foot	1,030	90	1	
										Fourth?	1,379	30		
400	Harvey Gray heirs	do	1,360	Lower Kittanning.	90	4	do	114	20	Murrysville	960	35	1,554	Produces gas.
										Hundred-foot	1,095	35		
										Fourth?	1,435	30		
401	Geo. A. Balsiger	do	1,450	do	170	4	do	200	10	Murrysville	1,038	30	1,068	Do.
402	J. H. Chrisman	do	1,460				do	190	20	do	1,050	40	1,582	Do.
										Hundred-foot	1,160	75	1	
403	C. M. Smith	do	1,180				do	35	10	Murrysville	890	30	1,439	Do.
										Hundred-foot	1,035	40		
										Fourth?	1,405	35		
404	Hamilton Chrisman	do	1,110							Murrysville	755	50	1,453	Do.
										Hundred-foot	915	40		
										do	985	30		
405	James D. Cobbett	do	1,080							Murrysville	740	30	1,311	Gas in Murrysville at 808 to 838.
										do	808	30		
										Hundred-foot	843	28		

406	S. E. Balsiger	do	1,470				Vanport	130?	10	Murrysville	1,014	26	1,540	Produces gas.
										Hundred-foot	1,080	110		
										Fourth?	1,490	50		
407	D. O. Collen	do	1,500	Lower Kittanning.	180	5	do	205	15	Murrysville	1,044	70	1,606	Gas at 1,076 and 1,583.
										Third?	1,475	20		
										Fourth?	1,538	68		
408	Maginnis	do	1,460	do	85	4	do	109	15	Murrysville	960	52		
										Hundred-foot	1,097	20	1,123	Gas in Murrysville.
409	J. E. Shoemaker	do	1,300?	Upper Kittanning?	50		do	196	8	Murrysville	1,026	126	2,505	A little gas at 1,590; abandoned.
										Hundred-foot	1,160			
										Fourth?	1,555	50		
										Fifth?	1,670	10		
										Speechley	2,415	40		
410	H. Pence	Climax Fire Brick Co.	1,370							Murrysville	867	68	1,421	Gas at 867.
411	Hettrick	do	1,340							do	780	45	872	Gas at 815.
412	Croson No. 2	do	1,390							Murrysville (part of).	904	16	1,428	Gas at 860.
										Hundred-foot	1,080	100		
413	Meredith	do	1,460				Vanport	50		Murrysville	955	45	1,502	Gas at 915 and 1,137.
										Hundred-foot	1,130			
414	Croson No. 1	do	1,300							Murrysville	762	17?	1,281	Gas at 820 and 850. Record defective.
										Hundred-foot	1,150	10?		
415	Stuart	do	1,330							Murrysville?	830	53	1,027	Gas at 780, 830 and 1,002. Record defective.
										Hundred-foot	1,002	10		

PLUM CREEK TOWNSHIP.

416	John Boyer	Eastern Oil Co	1,440	Upper Freeport.	360		Freeport	375		Murrysville	1,475		1,499	Gas at 1,482.
				Lower Freeport	420									
				Middle Kittanning?	515									
417	P. Rearick	do	1,250	Lower Freeport	200					do	1,275		1,888	Gas at 1,070, 1,140, and 1,445.
										Hundred-foot	1,365			

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

PLUM CREEK TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
418	Burns	Eastern Oil Co	1,350	Coal?	388	5	Vanport	393	10	Murrysville	1,230	46	1,958	Gas in Murrysville; gas at 1,462 and 1,631.
										Hundred-foot	1,432	54		
										Third?	1,604	32		
419	John Bell	do	1,345	Upper Freeport?	180	4	?Limestone	340	.....	Murrysville	1,295	.....	.....	Gas at 1,435, 1,633, and 1,665.
										Hundred-foot	1,430	88	1,719	
										Third?	1,605	35		
										Fourth?	1,660	40		
420	Madison Wagoner	do	1,460	do	285	.....	.....	.....	.....	Hundred-foot?	1,450	20	.....	Gas at 1,456, 1,720, and 1,770.
				Upper Kittanning?	400	.....	.....	.....	.....	Third?	1,716	.....		
										Fourth?	1,768	4		

COWANSHANNOCK TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
421	N. H. Duff	Philadelphia Co	1,260	Upper Freeport?	294	5?	.....	.....	.....	Murrysville	.....	.....	3,055	Produces gas.
										Hundred-foot	1,380	210		
										Fifth?	2,030	75		
										Tiona?	2,820	50		
422	David McCullough heirs.	do	1,150	.....	.....	.....	.....	.....	.....	Murrysville	1,274	64	2,084	Do.
										Hundred-foot	1,348	82		
										Fifth?	1,960	3		
423	Caroline Fisher	do	1,130	Upper Freeport.	75	5	.....	.....	.....	Murrysville	1,185	97	1,854	Produces gas; minute pressure: 1/41, 2/65 5/135, 10/215.
										Hundred-foot	1,285	100		
										Fifth	1,814	11		

424	A. A. Marshall	do	1,080	do	70	3				Murrysville	1,190	97		Produces gas.
										Hundred-foot	1,297	120	1,618	
425	W. C. Devinney	do	1,150	do	265	5				Murrysville	1,218	42	1,563	Do.
										Hundred-foot	1,270	105		
426	Wm. Bell	Eastern Oil Co	1,390	do	207		Freeport	215		Murrysville	1,244	93	1,682	Gas at 1,670.
										Hundred-foot	1,370	60		
										Third?	1,585	50		
										Fourth?	1,650	32		
427	Jacob Espey	do	1,220	Upper Kittanning?	215					Murrysville	1,230		1,595	Gas at 1,413 and 1,460; very light.
										Hundred-foot	1,348			
										Thirty-foot	1,455			
428	Wm. Boyer No. 1	do	1,220				Vanport	314	10	Murrysville	1,245	95	1,586	Gas at 1,245, 1,409, and 1,479.
										Hundred-foot	1,345	82		
										Thirty-foot	1,479			
429	J. H. Sowers No. 1	Pittsburg Plate Glass Co.	1,470				Freeport	290	15	Murrysville	1,405	50	2,094	Produces gas.
							Vanport	515	15	Hundred-foot	1,525	110		
										Fifth?	2,078	2		
430	McCurdy	Eastern Oil Co	1,410				Vanport	385		Murrysville	1,288	55	1,557	A little gas at 1,160; gas in Thirty-foot at 1,458.
										Hundred-foot	1,348	105		
										Thirty-foot	1,458	94		
431	S. & A. McCurdy No. 2	Pittsburg Plate Glass Co.	1,460	Upper Freeport	159	4	Freeport	168	15	Murrysville	1,308	27	1,588	Produces gas.
										Hundred-foot	1,445	61		
432	S. & A. McCurdy No. 1	do	1,450	do	155	4	do	170	15	Murrysville	1,305	60	1,569	Do.
										Hundred-foot	1,400	75		
433	Smith No. 1	Eastern Oil Co	1,240	do.?	21	1				Murrysville	1,110	37	1,167	Gas at 1,110, 1,150, and 1,160.
				Upper Kittanning.	90	4	Vanport	216						
434	Seitz No. 1	do	1,120				do	130	10	do	1,020	71	1,231	Gas at 1,020 and 1,140.
										Hundred-foot	1,096	115	1	
435	John Glazier	do	1,410				do	417		Murrysville	1,307	100	1,518	Gas at 1,307 and 1,462.
										Hundred-foot	1,427	86		
436	Louster Bros. No. 1	Pittsburg Plate Glass Co.	1,190							Murrysville	1,060	25	1,722	Produces gas.
										Hundred-foot	1,250	30		
437	J. S. Raraigh	Eastern Oil Co	1,160							Fourth?	1,508	30	1,646	Gas at 1,300; movement of upper sands.
										Fifth?	1,610	20		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

COWANSHANNOCK TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
438	Samuel Raraigh	Eastern Oil Co	1,140				Vanport	100		Murrysville	1,000		1,296	Produces gas.
										Hundred-foot	1,180			
439	Rainer	do	1,165				do	140	20	Murrysville	1,046	74	1,260	Gas in Hundred-foot.
										Hundred-foot	1,206	54		
440	C. Shetler	do	1,370				do	380		Murrysville	(?)		1,500	Gas at 1,286, 1,465, and 1,470.
										Hundred-foot	1,390			
441	H. Wampler	Pittsburg Plate Glass Co.	1,350	Upper Freeport	200	5	Freeport	215	8	Murrysville	1,318	82	2,040	Dry.
				Upper Kittanning?	268	5	Vanport	440	10	Hundred-foot	1,438	90		
442	J. W. McIntosh	Eastern Oil Co	1,240							Murrysville	1,210	75	1,427	Gas at 1,210, 1,366, and 1,378.
										Hundred-foot	1,328	70		
443	J. A. Bowser	do	1,280	Upper Freeport	155	4	Vanport	400		Murrysville	1,268	68	1,494	Gas at 1,278 and 1,440.
				Upper Kittanning?	228	4				Hundred-foot	1,373	103		
444	Robt. Bowser	do	1,370				Vanport	510		Murrysville	1,419		1,628	Produces gas.
										Hundred-foot	1,522			
445	James Peters	do	1,390	Upper Freeport	270		do	470		Murrysville	1,315	78	1,837	Gas at 1,419 and 1,595.
										Hundred-foot	1,532	100		
446	McKelvay	do	1,150				do	325		Murrysville	1,220		1,265	Gas at 1,220 and 1,236.
447	Crothers No. 1	Pittsburg Plate Glass Co.	1,310				do	345	18	do	1,268	89	1,969	
										Hundred-foot	1,398	115		
448	Pettigrew	Eastern Oil Co	1,070							Murrysville	1,887	24	1,126	Produces gas.
										Hundred-foot	1,065			
449	J. W. Kennerdell	Pittsburg Plate Glass Co.	1,090				Vanport	120	20	Murrysville	1,990	100	1,240	Gas at 995 and 1,176.
										Hundred-foot	1,100	140		

450	Reisinger	....do	1,100	Lower Kittanning.	105	6	....do	111	41??	Murrysville	1,015	100	1,763	Gas at 1,242.
										Hundred-foot	1,155	97		
										Fifth?	1,687	15		
451	Nell No. 2	Eastern Oil Co	1,125	....	....	....	....	....	....	Murrysville	1,154	.....	1,359	Gas at 1,153 and 1,322.
										Hundred-foot	1,299	105	1	
452	Crow No. 1	....do	1,300	Upper Freeport.	282	2	Vanport	498	18	Murrysville	1,376	71	1,625	
										Hundred-foot	1,480	115		
453	Gourley heirs	....do	1,180	....do	150	4	Freeport	160	15	Murrysville	1,260	65	1,427	Gas at 1,155 and 1,260.
				Upper Kittanning.	221	7	....	....	....	Hundred-foot	1,360	30		
				Lower Kittanning.	320	3								
454	Goldstein No. 2	....do	1,160	....	....	....	Vanport	110	....	Murrysville	1,017	.....	1,237	Gas at 1,030, 1,200, and 1,216.
										Hundred-foot	1,125	.....		
455	Daniel Schreckengost No. 1.	....do	1,275	Upper Freeport.	80	4	....do	320	20	Murrysville	1,165	85	1,276	Gas, at 1,210, and 1,230 to 1,240.
456	H. J. Hill	Pittsburg Plate Glass Co.	1,170	....	....	....	....do	172	10	....do	1,062	63	1,235	Gas at 1,077.
										Hundred-foot	1,185	50		
457	J. B. Powers	Eastern Oil Co	1,180	....	....	....	....do	232	....	Murrysville	1,118	59	1,288	Gas at 1,281 and 1,287.
										Hundred-foot	1,185	98		
458	Jerry Elgin	Pittsburg Plate Glass Co.	1,230	....	....	....	....do	246	10	Murrysville	1,134	76	1,345	Gas at 1,136 and 1,330.
										Hundred-foot	1,255	90		
459	A. Sowers	Eastern Oil Co	1,185	....	....	....	....do	237	....	Murrysville	1,130	90	1,335	Gas at 1,130, 1,142, 1,294, and 1,309.
										Hundred-foot	1,235	.....		
460	Jerry Elgin No. 2	Pittsburg Plate Glass Co.	1,360	Upper Freeport.	105	5	....	....	....	Murrysville	1,255	65	1,480	Gas at 1,220, 1,436, 1,442, and 1,463.
										Hundred-foot	1,385	95		
461	Wm. Schreckengost No. 1.	....do	1,375	....do	165	4	Vanport	444	10	Murrysville	1,322	28	1,590	
				....do.?	240	4	....	....	....	Hundred-foot	1,434	56		
				Upper Kittanning.	308	4	....	....	....	....	.....	.....		
462	Bittinger	Eastern Oil Co	1,335	....	....	....	....	....	....	Murrysville	1,260	100	1,471	Gas at 1,260 and 1,440.
										Hundred-foot	1,385	86		
463	Wm. Schreckengost No. 2	Pittsburg Plate Glass Co.	1,360	Upper Freeport	90	3	Vanport	366	20	Murrysville	1,260	100	1,917	Gas at 1,260 and 1,430.
										Hundred-foot	1,415	65		
464	Wm. Schreckengost No. 3.	....do	1,300	....do	100	4	....do	390	25	Murrysville	1,345	60	1,526	Gas at 1,345, 1,458, and 1,472.
										Hundred-foot	1,425	97		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

COWANSHANNOCK TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
465	D. A. McAfoose No. 1.	Pittsburg Plate Glass Co.	1,410	Brookville?	455	5	Upper Freeport.	380	5	Murrysville	1,310	85	1,480	Produces gas.
										Hundred-foot	1,410	70		
466	Torney heirs	Eastern Oil Co	1,438				do	395		Murrysville	1,255			Abandoned.
467	D. Oplinger	do	1,440				Freeport	116		do	1,240	74	1,527	Gas at 1,100, 1,240, 1,415, and 1,430; very light; abandoned.
										Hundred-foot	1,337	39		
										do	1,400	47		
468	Ben Hill No. 1	Pittsburg Plate Glass Co.	1,420	Upper Kittanning?	142	3				Murrysville	1,195	141	1,777	Gas at 1,199 and 1,373.
										Hundred-foot	1,373	62		
469	D. T. Schreckengost No. 4.	Eastern Oil Co	1,220							Murrysville	1,165		1,425	Gas in Murrysville at 1,210; in Hundred-foot at 1,355.
										Hundred-foot	1,275			
470	D. E. Schreckengost No. 1.	Pittsburg Plate Glass Co.	1,235				Vanport	70		Murrysville	970		1,262	Gas at 975.
										Hundred-foot	1,075	135		
471	Peart No. 5	do	1,110							Murrysville	850	83	1,174	Gas at 1,047 and 1,126.
										Hundred-foot	953	69		
472	A. Bowser	Eastern Oil Co	1,445	Lower Kittanning.	260					Murrysville	1,190	75	1,416	Gas at 1,229 to 1,251 and at 1,395.
										Hundred-foot	1,331	85?		
473	Brown	do	1,160	Brush Creek	50	2	Freeport	165	7	Murrysville	1,284	20	1,496	Gas at 1,284.
				Upper Freeport.	150	4	Vanport	400	15	do	1,320	30		
				Upper Kittanning.	210	8				Hundred-foot	1,370	30		
				Lower Kittanning.	330	3								

474	Kelm heirs	....do	1,240				Vanport	415		Murrysville	1,270	75	1,500	Gas at 1,270, and 1,454 to 1,464.
										Hundred-foot	1,350	95		
										Thirty-foot	1,454	44		
475	P. & J. Brown No. 1	....do	1,260	Lower Freeport	165	5	....do	350	5	Murrysville	1,244	85	1,472	Gas at 1.244, 1,252, 1,448, and 1,460.
										Hundred-foot	1,325	75		
										Thirty-foot	1,420	52		
476	Robt. Lynes	....do	1,260	....do	180	3	....do	365	20	Murrysville and Hundred-foot.	1,250	218	1,904	
477	C. O. Schreckengost	Pittsburg Plate Glass Co.	1,240				....do	275	30	Murrysville	1,155	[illegible]	1,396	Gas at 1,157 and 1,366; abandoned.
										Hundred-foot	1,270	96		
478	E. Schreckengost heirs	Eastern Oil Co	1,200				....do	232		Murrysville	1,117	93	1,340	Gas at 1,140 and 1,310.
										Hundred-foot	1,225	60		
										Thirty-foot	1,302	38		
479	Cogley	....do	1,385				....do	510		Murrysville	1,395		1,441	Gas at 1,395 to 1,423.
480	Kelly heirs No. 1	Pittsburg Plate Glass Co.	1,380	Upper Freeport.	230	7	Freeport	255	15	....do	1,350	70	1,470	Gas at 1,190.?
							Vanport	490	10					
481	E. Z. Schreckengost	Eastern Oil Co	1,210				....do	285					1,342	Gas at 1,170 and 1,342.
482	J. Carson	Pittsburg Plate Glass Co.	1,155	Middle Kittanning?	125	5								
				Brookville?	310	5	....do	204	8	Murrysville	1,065	55	1,100?	Gas at 1,090 and 1,100.
483	Samuel H. Gourley	Eastern Oil Co	1,225				....do	320		....do	1,185		1,450	Gas at 1,355 and 1,388.
484	James	....do	1,160				....do	195		....do	1,062	98	1,300	Gas at 1,114 and 1,281..
										Hundred-foot	1,175	80		
485	Samuel Moore	Cowanshannock Gas Co.	1,170	Upper Freeport.	80	4	....do	290	10	Murrysville?	1,135	40	2,810	Dry.
										Hundred-foot	1,230	105		
										Thirty-foot	1,345	35		
										Fifth?	1,760	40		
										Speechley	2,535	25		
										....do	2,630	20		
										Tiona	2,680	40		
										....do	2,760	30		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

WAYNE TOWNSHIP.

No.	Name.	Owner.	Elevation.	Coal seams.			Limestones.			Oil and gas sands.			Total depth of well.	Product.
				Name.	Depth.	Thickness.	Name.	Depth.	Thickness.	Name.	Depth.	Thickness.		
			Feet.		*Feet.*	*Feet.*		*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	
486	Wm. McIntire No. 3	Eastern Oil Co.	1,480							Murrysville	1,230		1,440	Murrysville gas at 1,230 (show); Hundred-foot gas at 1,418; gas at 1,100.
										Hundred-foot	1,353			
487	Peart No. 4	Pittsburg Plate Glass Co.	1,405							Murrysville	1,108	56	1,359	Gas at 1,136 and 1,307.
										Hundred-foot	1,215	42		
										Thirty-foot	1,305	54		
488	Wm. McIntire No. 2	Eastern Oil Co.	1,380				Vanport	230		Murrysville	1,120		1,305	Gas at 965, 1,120, and 1,290.
										Hundred-foot	1,235			
489	M. L. McIntire No. 2	do	1,320				do	120		Murrysville	1,030		1,265	Murrysville gas at 1,030 (show); Hundred-foot gas at 1,225, and 1,245.
490	Trautman No. 1	do	1,480				Vanport	370		Murrysville	1,233		1,445	Gas at 1,417 and 1,430.
										Hundred-foot	1,330			
491	M. L. McIntire No. 1	do	1,490							Murrysville	1,080	68	1,304	Gas at 1,260.
										Hundred-foot	1,172	46		
										Thirty-foot	1,248	37		
492	Jacob Rupp	do	1,400							Murrysville	1,165		1,414	Gas in Hundred-foot at 1,278 to 1,355; minute pressure: 1/25, 5/105, 10/152.
										Hundred-foot	1,275			
493	Wm. McIntire No. 1	do	1,330				Vanport	130	5	Murrysville	1,055	80	1,272	Gas at 1,060, 1,230, and 1,245; pressure: 1½/200.
										Hundred-foot	1,168	104		
494	W. L. Peart No. 1	Pittsburg Plate Glass Co.	1,170							Murrysville	870	63	1,112	Gas at 878 and 1,096.
										Hundred-foot	1,000	53		
										Thirty-foot	1,068	44		

495	W. L. Peart No. 3	do	1,170							Murrysville	900	30		Gas at 782, 925, 1,003, and 1,030.
										Hundred-foot	961	51		
										do	1,012	40		
										Thirty-foot	1,109			
496	W. H. Beck No. 2	People's Natural Gas Co.	1,090							Murrysville?	670	279	998	Gas at 675 and 993.
										Hundred-foot	965			
497	Mary A. Campbell	Eastern Oil Co.	1,320	Upper Freeport?	75?		Vanport	320		Murrysville	1,146	94	1,405	Gas at 1,169, 1,326, 1,346, and 1,390.
										Hundred-foot	1,248	152		
498	Alec Brice No. 1	Pittsburg Plate Glass Co.	1,215	Upper Kittanning.	110	5	do	255	10	Murrysville	1,114	56		Dry.
										Hundred-foot	1,200	141		
										Thirty-foot	1,361	30		
										Fourth?	1,550	20		
499	Laura Pontius	Eastern Oil Co.	1,260	Middle Kittanning.	170		do	248		Murrysville	1,120		2,681	Produces a little gas.
										Hundred-foot	1,200			
										Thirty-foot	1,360			
										Fourth	1,580			
										Fifth	1,732			
										Speechley?	2,410			
										Tiona?	2,600			
500	Wm. Wadding	do	1,400	Middle Kittanning?	220		do	300		?	980		1,035	Heavy gas in sand at 980, but soon exhausted. This is not the Murrysville sand.
501	N. H. Rupp	do	1,430	Upper Kittanning?	160	5	do	330	10	Murrysville	1,192	36	1,399	Produces gas.
										Hundred-foot	1,290	65		
										Thirty-foot	1,325	20		
502	S. S. Schreckengost	do	1,220				do	120		Murrysville	980	40	1,020	Gas at 1,000.
503	Stoops	People's Natural Gas Co.	1,220	Brookville	185	3	do	92	12	do	910	25	2,380	Dry.
										do	950	30		
										Fourth?	1,420	20		
										Speechley??	2,100	20		Probably not Speechley.
504	Williamson Bros. No. 1?	do	1,180				do	40?		Murrysville	940	30	1,225	Gas at 940.
										do	990	40		
										Hundred-foot	1,050	40		
										Thirty-foot	1,120	90		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

WAYNE TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
505	Joshua Foster No. 2	Apollo Gas Co	1,300							Murrysville	911	58	1,090	Dry.
										Hundred-foot	984	22		
										Thirty-foot	1,024	40		
506	Leopold Drohn	People's Natural Gas Co.	1,250							Murrysville	915	32	1,141	Do.
										Hundred-foot	1,020	100		
										Thirty-foot	1,115	75		
507	J. A. White	Apollo Gas Co	1,330							Murrysville	785	27	817	Gas in Murrysville.
508	Sarah White	People's Natural Gas Co.	1,350				Vanport	65		do	900		925	Gas at 900.
509	David White No. 1	Apollo Gas Co	1,405							Murrysville	800	18		
										Hundred-foot	860	28	888	Gas in Hundred-foot.
510	David White No. 3	do	1,600							Murrysville	1,060	15	1,093	Gas at 930 and in Murrysville.
511	David White No. 2	do	1,460				Vanport	45	8	Murrysville	922	20	942	Gas at 795; gas in Murrysville.
512	J. W. Halderman	do	1,470	Clarion	108	3	do	70	8	do	946	15	961	Gas in Murrysville; minute pressure: 1/195, 2/245, 5/272.
513	John Snyder No. 1	People's Natural Gas Co.	1,440				do	70						Produces gas.
514	Rebecca Martin No. 2	Apollo Gas Co	1,440	Brookville	150	3	do	45	8	?	765	10	775	Gas at 765.
515	Rebecca Martin No. 1	do	1,500	Lower Kittanning.	59	3	do	92	10	Murrysville	967	19	1,139	Gas in Murrysville.
										Hundred-foot	1,016	103		
516	J. A. White No. 2	do	1,610	do	140	4								
				Brookville	274	6				Murrysville	1,080	16	1,112	Gas at 1,096.

517	Thomas Alcorn	Pittsburg Plate Glass Co.	1,425				Vanport	115		do.?	951		1,662	Dry.
										Hundred-foot	1,130			
518	W. F. Snyder No. 1	do	1,473				do	83		Murrysville ?	915		944	Produces gas.
519	C. Snyder No. 1	People's Natural Gas Co.	1,480				do	45	10	do.?	915		930	Do.
520	G. C. Stockdill No. 1	Apollo Gas Co	1,548				do	175	8	Murrysville	1,037	18		
										do	1,065	8	1,080	Gas in Murrysville.
521	G. C. Stockdill No. 2	do	1,500?	Lower Kittanning.	104	4	do	132	8	do	980	15	1,158	Gas at 1,015; minute pressure: 1/37, 2/60, 5/125; rock pressure, 280 pounds.
										do	1,005	20		
										Hundred-foot	1,035	85		
										Thirty-foot	1,130	20		
522	John Snyder	do	1,513	do	100	3	do	130	8	Murrysville	978	20	998	Gas in Murrysville.
523	G. C. Stockdill No. 3	do	1,533	do	100	2	do	158	7	do	999	23	1,027	Gas at 906 and in Murrysville.
524	Concord Church	Pittsburg Plate Glass Co.	1,660	Middle Kittanning?	190		Freeport	40	10					
							Vanport	270		Murrysville	1,115		1,685	Gas in Murrysville.
										Hundred-foot	1,215			
										Fourth ?	1,605			
525	Jos. Clever No. 2	Apollo Gas Co	1,560	do	100	2	do	190	10	Murrysville	1,050	32	1,229	
										do	1,128	31		
										Hundred-foot	1,171	38		
526	Geo. Reeseman	do	1,320							Murrysville	880?	70?	1,200	Produces gas.
										Hundred-foot	970	63		
										Thirty-foot	1,065	43		
527	Jos. Clever No. 1	do	1,420				Vanport	50	10	Murrysville	900	65	1,637	Dry.
										do	975	35		
										Hundred-foot	1,025	20		
										do	1,060	25		
										Thirty-foot	1,115	30		
528	James Butler	Philadelphia Co	1,500				do	195	10	Murrysville	1,025	115	1,375	A little gas at 1,090.
										Hundred-foot and Thirty-foot.	1,145	205		
529	Conrad Berline	People's Natural Gas Co.	1,400	Brookville	139	3				Murrysville	925	55	1,080	
										Hundred-foot	925	35		
										Thirty-foot	1,055	20		

Partial records of oil and gas wells in the Kittanning and Rural Valley quadrangles—Continued.

WAYNE TOWNSHIP—Continued.

No.	Name.	Owner.	Elevation.	Coal seams. Name.	Coal seams. Depth.	Coal seams. Thickness.	Limestones. Name.	Limestones. Depth.	Limestones. Thickness.	Oil and gas sands. Name.	Oil and gas sands. Depth.	Oil and gas sands. Thickness.	Total depth of well.	Product.
			Feet.		Feet.	Feet.		Feet.	Feet.		Feet.	Feet.	Feet.	
530	H. S. Pontius No. 1	People's Natural Gas Co.	1,370							Murrysville	835	95	2,327	Dry.
										Hundred-foot	935	60		
										Fourth	1,250	30		
										Speechley	2,200	60		
531	D. Snowden	do	1,460				Vanport	60	10	Murrysville	918	10	928	Gas at 918.
532	Jewell heirs	do	1,550	Lower Kittanning.	36	3	do	83	8	do	966	59	1,220	
										Hundred-foot	1,056	74		
										Thirty-foot	1,155	20		
533	A. H. West	do	1,430	do	28					Murrysville	854		870	Gas at 859.
534	W. S. McCullough No. 1.	do	1,450				Vanport	67		do	880	10	890	Gas at 880.
535	Daniel West	do	1,415	Brookville ?	129	6				do	850	75		
										Hundred-foot	945	80	1,069	Gas at 855, 875, and 955.
536	H. L. & G. M. Ellenberger.	do	1,430				Vanport	40		Murrysville	852		865	Gas at 852.
537	Catherine Bittinger	do	1,300	Brookville	22					Murrysville	790	75	991	Produces gas.
										Hundred-foot	882	87		
538	W. J. Bargerstock	do	1,390	Mercer ?	181		Vanport	30	10	Murrysville	888	52	2,373	Gas at 926.
										Hundred-foot	977	123		
										Thirty-foot	1,115	20		
										Fifth	1,520	40		
										Speechley	2,308	35		
539	Wall and Kammerdiener.	Apollo Gas Co	1,520				do	217	6	Murrysville	1,035	51	1,281	Gas at 1,090 and 1,185.
										Hundred-foot	1,120	95		
										Thirty-foot	1,225	31		

540	Hoffman No. 1	Pittsburg Plate Glass Co.	1,520				do	210	8	Murrysville	1,070	30	1,545	Abandoned.
										Hundred-foot	1,148	104		
										Thirty-foot	1,308	17		
541	Geo. Reeseman No. 1	do	1,500?				do	25	7	Murrysville	1,120	50	1,308	Gas at 1,120 and 1,220.
										Hundred-foot	1,250	50		Location uncertain.
						MAHONING TOWNSHIP.								
542	Stockdill ?	People's Natural Gas Co.	1,190				Vanport	35	4					
543	John Colwell	Carnegie Natural Gas Co.	920							Murrysville	808		2,719	Produces gas.
										Hundred-foot	930	85		
										Fourth	1,302	48		
										Speechley	2,104	70		
										Tiona	2,270	50		
544	Colwell No. 4	Bethlehem Gas Co.	1,200	Mercer ?	391		Vanport	236						
545	Anna Doverspike	People's Natural Gas Co.	1,030				Mercer	60	12	Murrysville	853	24	2,636	Gas in Murrysville and Hundred-foot.
										Hundred-foot	960	115		
										Speechley ?	2,235	40		
										Tiona ?	2,585	17		
						REDBANK TOWNSHIP.								
546	John Shaffer	Redbank Natural Gas Co.	1,160				Vanport	20					1,133	Dry.
547	Avon Hulbin	do	1,240				do	48		Murrysville	860?		1,207	Gas at 860.
548	Geo. Shaffer	do	1,250				do	30					1,100	Gas at 1,070.
549	Lankerd heirs	Fairmount Gas Co.	1,480				Mercer ?	280		Murrysville	1,035		1,222	Gas at 1,130 and 1,182.
										Hundred-foot	1,118	40		
										Thirty-foot	1,170	42		

CLAY AND SHALE.

An abundance of clay exists in these quadrangles as the underclays of several of the coal seams. The most important of these and the only ones utilized at present are the Mercer fire clay of the Pottsville formation and the Clarion and Lower Kittanning fire clays of the Allegheny formation. The Upper Freeport fire clay, however, is generally of good thickness, and might be used to advantage under favorable conditions. The shale at present used in the quadrangles comes from the Allegheny formation, and abundant supplies can doubtless be obtained at easily accessible points. The sandy shales so abundant in the Conemaugh formation in several parts of the quadrangles might also be found suitable for the manufacture of certain grades of brick.

From its very nature clay does not tend to outcrop boldly or clearly, so that while its presence may be indicated in road cuttings or hillside washings it is seldom that these give an accurate idea of its thickness or quality. For that reason, while this report indicates the areas where the different clays outcrop above drainage and briefly their positions from point to point in those areas, accurate information as to their thickness and quality outside of the areas of development can only be obtained by actual prospecting on the part of those interested. Again, it should be recalled that in a majority of cases the only true test of the quality of a clay is in the kiln, where private interests take the initiative. From the close association of the clays with the coals it is possible to see on the geologic maps their lines of outcrop. Thus the line on the map separating the Conemaugh and Allegheny formations gives with great accuracy the position of the outcrop of the Upper Freeport clay. The position of the Lower Kittanning clay is likewise readily traced by following the line of outcrop of the Lower Kittanning coal, marked (lk) on the maps. The position of the Clarion is about 30 feet below the Vanport limestone, the outcrop of which is shown on the maps by the green line near the bottom of the Allegheny formation. By measuring down from the green line 1½ contour intervals its position at any point is easily determined. In the case of the Mercer clay its position will be closely shown by drawing a line through the middle of the Pottsville outcrop.

As an aid to finding these outcrops on the maps as well as on the ground brief descriptions of the distribution of the different clays are given in this report.

MERCER FIRE CLAY.

Stratigraphic position.—This occurs in the Pottsville formation in the shaly interval between the Homewood and Connoquenessing sandstones (see section on page 30). It is correlated with the Mount Savage fire clay of Allegheny County, Md.

Thickness and character.—This clay is not well known outside of the district of its development on Redbank Creek. At St. Charles it has a thickness up to 8 or 10 feet. At the pit mouth it is 6 feet thick with 2½ feet of flint clay at bottom; further in, where worked at present by the Clarion Fire Brick Company, it is all a flint clay, though of varying quality. Formerly the plastic clay used for bond by this company was imported, but recently a mine has been opened directly opposite the plant in a bed of plastic clay. This clay is at the same horizon as the flint clay, or at a closely adjacent horizon in the Mercer. At Climax the clay has a thickness of 12 feet and is composed of flint and plastic clay in varying proportions. The relations of the two kinds of clay also vary greatly; the flint clay may be at the top, middle, or bottom; it may be wanting in parts of the bed or may make up the full thickness in others. As a rule the flint clay makes up about one-third of the whole. Only the lower part of the plastic clay is mined.

The supply at St. Charles is said to be holding out well toward the south and west, and it is also satisfactory at Climax, though said to be cut out by other rock in certain directions.

Below is an analysis of the Mercer clay from the vicinity of Climax, made by A. S. McCreath:

Analysis of Mercer clay.

Silica	44.610
Alumina	38.010
Protoxide of iron	1.251
Titanic acid	1.020

A. VIEW OF KITTANNING CLAY MANUFACTURING COMPANY'S WORKS AT KITTANNING.

B. VIEW OF KITTANNING CLAY MANUFACTURING COMPANY'S QUARRY AT KITTANNING.

Lime	.080
Magnesia	.407
Alkalies	1.735
Water and organic matter	13.630
	100.743

Distribution.—The Mercer clay has as yet been but little exploited in these qaudrangles, present developments being confined to the vicinity of St. Charles and Climax, on Redbank Creek. The horizon of this clay is above drainage in the region about Craigsville, on Buffalo and Patterson creeks, and should be found about 100 feet above drainage near the junction of Patterson Creek and Long Run, under the Kellersburg anticline. It descends rapidly from this maximum elevation and passes below drainage about a mile to the north, a short distance south of Craigsville and about a mile west of Craigsville, on Buffalo Creek. No Mercer clay is known in this region.

On the Allegheny River the horizon of this clay appears above drainage at Templeton and rises rapidly until it is about 300 feet above river level over the Kellersburg anticline; then it descends slowly until in the vicinity of East Brady it is about 100 feet above the river. Up Redbank Creek this clay horizon is above drainage as far as the southern point of Anthonys Bend, a short distance above Climax. At St. Charles the clay is about 240 feet above the creek. At Climax it has descended until not far above creek level. Below St. Charles the clay horizon gradually descends until about 100 feet above the creek at Lawsonham. Some question exists as to the continuity of this clay between Climax and St. Charles. On the other hand prospecting is said to show the presence of the clay for a distance of 10 miles above and below St. Charles. On Mahoning Creek this clay horizon is above drainage from the mouth to a short distance above Dee. It reappears a short distance east and runs up a branch to the north to within a mile of Kellersburg. It is about at drainage level for a distance below Putneyville. About 1 mile northeast of Putneyville it rises above the creek and continues to get higher in the hills to the eastern edge of the quadrangle, where it is about 200 feet up the hills. No clay, however, is known to occur at this horizon in Mahoning Creek, nor any of value along the river.

CLARION FIRE CLAY.

Stratigraphic position.—At Kittanning and vicinity the Clarion fire clay and the fire clay and shale associated with the Lower Kittanning coal are being utilized largely in the manufacture of brick. The relationship of the Clarion clay bed to the rocks above, as they are developed at Kittanning, is shown in the following section:

Section showing Clarion fire clay and associated rocks at Kittanning.

	Feet.
1. Dark clay shale	25
2. Lower Kittanning coal	3-3½
3. Kittanning fire clay	12
4. Sandy shale	10
5. Buhrstone ore	1
6. Vanport (Ferriferous) limestone	9
7. Dark sandy shale or shaly sandstone	10
8. Shale or slate	20
9. Little or no coal	
10. Clarion fire clay	8-10

The beds, 1 to 6, inclusive, are exposed in the quarry of the Kittanning Clay Manufacturing Company, as shown in the accompanying illustrations (Pl. X).

As shown in the section the Clarion clay lies about 30 feet below the Vanport limestone. It is usually overlain by a thin coal seam, the Clarion coal.

Thickness and character.—The Clarion clay generally occurs as a high-grade plastic clay, although some flint clay occurs at this horizon. It is suited for use in making gray or buff building brick, sewer pipe, and as a bond for fire brick. It has also been successfully used

in the manufacture of tile and pottery. Along the Allegheny River most of this clay is drab in color, breaking along slickensided surfaces. Toward the top the clay tends to be darker in color, while toward the bottom it tends to become sandy. The best clay usually has a pearly luster and smooth soapy feeling.

At West Winfield the Clarion clay is 4 to 8 feet thick. The best clay is at the top, the bottom being more sandy. At Buffalo Mills the following exposure occurs one-fourth mile south of the bridge over the creek:

Section of Clarion clay at Buffalo Mills.

	Ft.	in.
1. Coal (Clarion)	1	8
2. Clay, black, slightly sandy		8
3. Clay, drab, crumbly, sulphur stain (from coal?)	2	7
4. Clay, dark gray, sandy	1	
5. Clay, drab		9
6. Clay, gray, very sandy	2	
7. Clay, gray, smooth (best)	2	6
8. Clay, drab, smooth	1	
9. Clay, dark gray, sandy	2	6
Sandstone.		

The section shows about 8 feet of good plastic clay. In this region the Clarion clay is said to average 6 or 7 feet thick. At a 2-foot exposure of this clay on the west side of Allegheny River, three-fourths mile north of the bridge at Kittanning, the clay appears to be of excellent quality, containing only a trace of sand and but little carbonaceous matter, apparently stem remains. In the mines at Neale (Ewing) this clay is 9 to 10 feet thick and holds this average well. The upper 4 feet of the clay is black. This is not mined when the clay is to be used as a bond for fire brick. At the Cowanshannock mine the clay is 8 feet thick, including 12 to 15 inches of black clay at top not mined. The clay becomes sandy 100 yards in the hill on the south side of the creek, but holds good for 300 yards in on the north side. At Templeton the clay is 10 feet thick, all white. The upper black layer present at Neale is absent here. At both places the clay is hard enough to require blasting in the mines.

Eastward from the Allegheny River the few exposures of this clay seen did not promise as good quality as along the river. Just north of South Bethlehem this clay is more sandy and harder. Outcrops of the clay were noted along Mahoning, Pine, and Cowanshannock creeks, but usually only in the form of weathered blooms from which little idea of the thickness or quality could be gained.

The chemical character of this clay is shown by the following analyses. The first is by McCreath (H5, p. 246), of a specimen from Kittanning. The second is from a specimen from Mahoning Creek. The third is given as an average analysis for the Allegheny River region.

Analyses of Clarion clay.

Constituent.	1.	2.	3.
Silica	58.750	56.350	57.00
Alumina	25.170	28.064	28.00
Protoxide of iron	2.195	3.237	2.80
Protoxide of manganese	Trace.		
Titanic acid	1.050		
Lime	.710	.520	.50
Magnesia	.936	.646	.60
Alkalies	3.535	2.925	2.40
Water	8.110	8.400	8.70
	100.456	100.142	100.00

Distribution.—Starting from the west, this clay outcrops in these quadrangles on Buffalo Creek. It is above drainage over two areas, the first in the vicinity of West Winfield, the second above Buffalo Mills. In the lower area it appears above water level at the mouth of Rough Run. It can be traced up Rough Run for 1½ miles, up Buffalo Creek to the mouth of the next run to the north, and up that run for a mile. Where worked at West Winfield it is 20 feet above the creek, and over the whole area it hardly gets more than 40 feet above drainage. At the sandstone quarry at West Winfield the clay is on top of the sandstone at an elevation of about 40 feet above Rough Run. In the Buffalo Mills area it appears from one-half mile to a mile below Buffalo Mills, and extends nearly to Fosters Mills, near Patterson Creek, on the north, and nearly to the county line on the west on Buffalo Creek. At Buffalo Mills it outcrops one-fourth mile below the bridge, being well exposed in a 13-foot cut (section, p. 164) about 15 feet above Buffalo Creek. It has been opened on a branch west of Buffalo Mills. It reaches 200 feet above drainage on the arch of the Kellersburg anticline.

The clay next outcrops in the immediate valley of Allegheny River. On the west side of the river the clay appears above the bottoms three-fourths mile above the bridge at Kittanning. It rises rapidly to the north. It is about 120 feet above the river at the mouth of Limestone Run, and extends up the run to Adrian. It shows one-fourth mile north of the Buffalo, Rochester and Pittsburg Railroad bridge, and goes under the bottoms a mile north of that bridge. It emerges again opposite the lower island south of Templeton, and is exposed north of the upper island in a slide. From here it rises under the Kellersburg anticline until opposite Rimer it is well up in the hilltops about 400 feet above the river. From there it descends to East Brady, where it is about 150 feet above river level. It extends up Huling Run to Sherrett, and up Sugar Creek to the mouth of Pine Run.

On the east side of Allegheny River the Clarion clay has been found in a shaft of the Kittanning Clay Manufacturing Company at 30 feet below the limestone at the bottom of the quarry. It emerges above the bottom lands at the northern edge of Kittanning. At Wickboro it is mined at an elevation of 866 feet above tide, nearly 100 feet above the river, the latter being about 772 feet. At Neale (Ewing) the clay is worked, the elevation being a little higher. It is reported to reach its maximum elevation (886 feet) just back of the Cowanshannock station. Up Cowanshannock Creek it goes below the surface four-fifths of a mile from the mouth. Continuing up the Allegheny the clay descends and passes below the bottoms 500 feet south of the Buffalo, Rochester and Pittsburg Railroad bridge at Mosgrove. It is well exposed back of the power house south of the station.

It is again brought up by the Kellersburg anticline. It first appears about 2 miles south of Templeton. At the old mine a little southeast of the station at Templeton its elevation is 943 feet above tide. It extends up Whisky Run about three-fifths of a mile. Up Mahoning Creek the clay has been traced to the mouth of Scrubgrass Creek. Its horizon keeps above drainage level of Mahoning Creek to the eastern edge of the Rural Valley quadrangle. Up Scrubgrass Creek it passes below drainage a short distance above the mouth. It reappears on the same creek a mile above Goheenville, and is above but close to drainage for nearly 2 miles. On Mahoning Creek the clay keeps within 100 feet above drainage, averaging about 60 feet to a point above Mahoning Furnace. It shows well in the road near the bridge over the creek 2 miles south of Deanville. From Mahoning Furnace to the edge of the quadrangle it rises toward the Greendale anticline, being about 100 feet above creek level at Putneyville, and rising until it is about 350 feet above the creek at the eastern margin of the quadrangle. It extends up all the branches of Mahoning Creek for varying distances.

Above Mahoning up the Allegheny River the Clarion clay horizon reaches an altitude of 1,200 feet, or 400 feet above the river. This elevation is maintained nearly to the mouth of Redbank Creek. Going up Redbank Creek its elevation increases until at St. Charles it is nearly 1,400 feet above tide, or still 400 feet above drainage. Thence it descends until at South Bethlehem it is less than 100 feet above creek level. Above the mouth of Redbank

Creek the clay descends to an elevation below 1,100 feet, which elevation it keeps all about East Brady and to the edge of the quadrangle.

The Greendale anticline brings the clay up in the valleys of Pine and Cowanshannock creeks. On the North Fork of Pine Creek this clay is above drainage for half a mile below and a mile above Slabtown. On the South Fork of Pine Creek it appears above creek level near Pine Furnace and passes under a half mile below Echo. At Oscar it is about 100 feet above creek level. The clay was noted at numerous points between Pine Furnace and Echo. On Cowanshannock Creek the clay rises within a mile below Stone House, and passes under the bottoms just above Greendale. It shows well in the road bank opposite the schoolhouse one-fourth mile west of Greendale.

KITTANNING FIRE CLAY.

Stratigraphic position.—The Kittanning clay immediately underlies the Lower Kittanning coal, as shown in the section below.

Thickness and character.—The clay is usually a plastic clay, though it carries some flint clay locally. As a rule it appears to be inferior to the Clarion. It is not as regular in thickness as the Clarion, being pockety; and, while up to 12 feet thick in places, is largely cut out by shale in other areas not far away.

At West Winfield the Kittanning clay is 11½ feet thick. It was formerly worked here, but is not now used. It is more suitable for tile than brick, since it does not make an article of uniform color. Around Buffalo Mills it is stated that the Kittanning clay and the underlying shale together average about 30 feet. Around Kittanning this clay has been extensively worked in connection with the shale below the coal. In the quarry of the Kittanning Clay Manufacturing Company it shows a maximum thickness of 12 feet, but as shown in Pl. X, *A*, it thins out rapidly along the dip to the east. The whole thickness of the clay at the Kittanning Clay Manufacturing Company's plant is plastic. The fire clay above makes buff building brick. A small amount has been used in connection with imported flint clays in making fire brick. In the southern part of the quarry at the Daugherty Brothers' plant at Kittanning some of the red shale above the Vanport limestone is replaced by plastic clay. This clay is of a better quality than the clay above, which comes just below the Lower Kittanning coal. It, however, contains iron concretions that have to be picked out. Between the upper and lower beds of plastic clay there also is a pocket of flint clay. A section in this quarry shows as follows:

Section of rocks in Daugherty Brothers' quarry, Kittanning, Pa.

	Ft.	in.
1. Coal, Lower Kittanning	4	
2. Fire clay, "bastard"	5	
3. Flint clay	1	6
4. Coal		4
5. Clay, buff	1	
6. Sandstone	1	
7. Coal		8
8. Fire clay, soft	8	
9. Shale, red	2	
10. Limestone, Vanport (Ferriferous)	7	

A short distance north of this the red shale is 10 feet thick and apparently cuts out the 8 feet of clay above, while between the "bastard" fire clay and the red shale is 18 inches of sandstone and 3 feet of buff clay, the coals and flint clay being out.

A sample of Kittanning clay from a ravine across the river from Neale (Ewing) showed a steel-gray color, with a high percentage of sand. It contained black plant stems, and was stained with sulphur. In a cut on the Buffalo, Rochester and Pittsburg Railroad just west of West Mosgrove station there is 15 feet of Kittanning clay and shale under the coal. The upper 7 feet is drab and crumbly; the lower 8 feet is drab and shaly. The clay appeared to be of excellent quality. The clay was formerly worked in the vicinity of Allegheny Furnace, opposite the mouth of Cowanshannock Creek, and according to Platt yielded both

flint and plastic clay of good quality. In a cut in new railroad grade 1½ miles above the Buffalo, Rochester and Pittsburg Railroad bridge on the west side of the river occurs 8 feet of clay below 8 inches of coal. In the trolley cut 2 miles west of Stone House a coarse clay, apparently just above the Lower Kittanning coal, shows 9 feet thick, the upper 4 feet being a dark gray and the lower 5 feet a lighter gray color, but hard and sandy. One-fourth mile west of Pine Furnace this clay appears to be thin and sandy.

An analysis of this clay at Kittanning, furnished by Mr. George W. McNees, is given below:

Analysis of Kittanning fire clay.

	Per cent.
Silica (SiO_2)	60.40
Alumina (Al_2O_3)	26.23
Ferric oxide (Fe_2O_3)	1.34
Ferrous oxide (FeO)	.23
Lime (CaO)	.14
Magnesia (MgO)	.54
Potash (K_2O)	2.66
Soda (Na_2O)	.28
Loss on ignition (H_2O, etc.)	8.71

Distribution.—The Kittanning clay is above drainage on Buffalo Creek around West Winfield, lying about 60 feet above the Clarion, but with a crop line nearly or quite twice as long. It rises above Buffalo Creek about 2 miles below Buffalo Mills, and is above drainage to above the county line up Buffalo and to Fosters Mills, near Patterson Creek. It rises above the bottom lands of the Allegheny just south of Kittanning, extends up Limestone Run to above Morrows Corner, up Cowanshannock Creek for 2 miles from the mouth, then rises again a mile below Stone House to again pass under near the mouth of Huskins Run. The Fairmont syncline carries the clay below drainage for a short distance on both forks of Pine Creek just above their junction. On the south fork it is above the creek nearly to Echo, and on the north fork to about 1½ miles above Slabtown. The clay keeps above the bottoms of the Allegheny River above Pine Creek. Up Mahoning Creek it is above drainage to the eastern edge of the quadrangle.

In a ravine to the south about half a mile above Dee the following section of this clay is exposed:

Section in ravine near Dee, Pa.

	Feet.
1. Lower Kittanning coal	2-3
2. Concealed	5
3. Sandstone	3
4. Clay	6
5. Sandstone	3
6. Clay (partly flint)	10
7. Clay, with sandstone and iron ore (?) layers	10
8. Vanport limestone.	

The 6 feet of clay of No. 4 probably is Kittanning. In the neighborhood of Mahoning Furnace it is less than 150 feet above creek level, but it rises to the east and west, so that at the eastern edge of the Rural Valley quadrangle it is nearly 1,500 feet above tide, or about 450 feet above drainage. This brings it high in the hills over the northeast corner of the area. On account of the steepness of the banks on Redbank Creek the outcrop line of the Lower Kittanning clay nearly coincides on the economic map with that of the Clarion, already described, except that it is 60 feet higher and extends a little farther up the side branches. Between the mouths of Mahoning and Sugar creeks this clay is well up in the hills, but gets much lower toward East Brady. It extends up Sugar Creek to Kaylor.

FREEPORT FIRE CLAY.

Stratigraphic position.—The Freeport fire clay occurs beneath the Upper Freeport coal, and as this is at the top of the Allegheny formation, the position of the clay in the hills can be determined by noting on the geologic map the dividing line between this and the

Conemaugh formation. In the western part of the Kittanning quadrangle immediately south of Chicora this seam becomes a flint clay, 10 feet or more thick, which apparently has an extent of several square miles. Although nothing is known of its qualities, the thickness and extent of the bed and its proximity to the railroad would seem to warrant an investigation on the part of investors.

At Cowansville about 4 feet of plastic clay occurs in the top of the shale quarry. In the central part of the area covered by the two quadrangles the Freeport clay is partly flint, and along Allegheny River is reported to average about 6 feet in thickness. The plant at Manorville, which now makes silica brick exclusively, formerly used flint clay from this bed for making fire brick, but as the clay was found only in small pockets the mine was abandoned. The quality and thickness of the seam in the vicinity of Yatesboro is indicated by the following general section given by the superintendent of the coal mines at that place:

Section of Freeport fire clay near Yatesboro.

	Feet.
Fire clay and sandstone	1
Hard and sandy fire clay	4-5
Hard flinty rock	3-4
Impure limestone	6-7

McCreath analyzed specimens of this clay from the vicinity of Allegheny Furnace and from Kittanning, which results are given below. No. 1 is from Allegheny Furnace opposite the mouth of Cowanshannock, No. 2 is from Kittanning (H5, pp. 240 and 246).

Analyses of Freeport fire clay from Allegheny Furnace and Kittanning.

Constituent.	1.	2.
Silica	50.370	58.750
Alumina	32.890	25.170
Protoxide of iron	1.641	2.195
Titanic acid	1.030	1.060
Lime	.310	.710
Magnesia	.353	.936
Alkalies	.290	3.535
Water	13.760	8.110

Distribution.—The Upper Freeport clay is above the main lines of drainage over practically all of the Kittanning quadrangle. In the northwest corner of the quadrangle it comes near the middle of the hill slopes. Going southeast toward the Kellersburg anticline this clay rises until all over the central and northern central part of the quadrangle it occurs well up on the upland, in some cases occupying small isolated areas on hilltops only. This is especially true going eastward toward the Allegheny at Mahoning. In the southern and southeastern part of this quadrangle the Boggsville and Fairmont synclines bring the Freeport clay down into the valleys, so that at the southern edge of the quadrangle the clay is not far above drainage on Buffalo Creek or Allegheny River.

In the northwest corner of the Rural Valley quadrangle this clay horizon comes above the hilltops and has been removed. East of Kellersburg it comes into the tops of the hills, and northeast of Mahoning Furnace it lies well under their summits, but east of Eddyville it again rises above the tops of the hills. Between Mahoning Creek and Pine Creek it lies well under the upland, or in the lower valleys at the west, but to the east it rises and is above most of the hilltops around Belknap. South of Pine Creek it is well down in the valleys at the west, rises well up on the hills in crossing the Greendale anticline about Greendale and Oscar, then descends and passes below drainage on Cowanshannock Creek at Yatesboro. It is below drainage over all of the southeast corner of the Rural Valley quadrangle.

SHALE.

This is utilized in these quadrangles only at Kittanning by the Kittanning Clay Manufacturing Company and by Daugherty Brothers. The following beds shown in the section on page 168 are used. From No. 1 is made a fine vitrified brick for building fronts; from No. 4 is made a vitrified brick and building brick; from No. 7 is made a building brick, and No. 8 is said to be suitable for buff fire brick and for sewer pipe. Mention has already been made of the shale associated with the Kittanning clay about Buffalo Mills, the two there being reported as averaging 30 feet thick. From exposures at several places it appeared possible that this shale would repay investigation.

At the Du Bois & Butler Brick Company's plant at Cowansville the shales between the Upper and Lower Freeport coals are worked. The section here shows as follows:

Section near Cowansville.

	Ft.	in.
1. Surface and sandstone fragments	4	
2. Clay, whitish	4	
3. Shale, greenish gray	5	
4. Shale, black	12	
5. Coal (Lower Freeport)	4	6
6. Fire clay (concealed)	4	?

The clay at the top runs gradually into the shale below, which from being stained red is called "red shale." The shale is not very hard and but slightly gritty. The black shale is somewhat harder and not at all gritty. The clay and gray shale are very plastic, and depend upon mixing with the black shale to give the resulting brick the necessary refractory qualities.

At the cut on the Buffalo, Rochester and Pittsburg Railroad below the second bridge east of Cowansville the shales below the lower Freeport coal are exposed, as shown in the following section:

Section in railroad cut east of Cowansville.

	Ft.	in.
1. Shale, red, fissile	6	
2. Coal (Lower Freeport)	4	
3. Clay, drab		11
4. Carbonaceous layer		8
5. Clay, drab	5	
6. Shale, drab	6	6
7. Sandstone, gray		6
8. Shale, gray	3	
9. Shale, black	5	

The shales at this point appear to be inferior to those at Cowansville.

A fine-grained, olive-green shale near the horizon of the Upper Freeport coal outcrops on the east slope of the hill east of Kittanning. At Yatesboro it is stated that the air shaft went through 60 feet of shale above the Upper Freeport coal. Tests are being made of shales on the Kroh farm, just east of Yatesboro, but have not yet reached the point of demonstrating the workability of the shales there. Similar shale to that at Yatesboro outcrops at several points around Rural Valley, in places suggesting a thickness of 90 feet

The following analysis of one of the shales worked at Kittanning is furnished by Mr. George W. McNees:

Analysis of shale at Kittanning.

Silica (SiO_2)	55.17
Alumina (Al_2O_3)	19.92
Iron oxide (Fe_2O_3)	12.01
Loss on ignition (H_2O, etc.)	6.81

EXPLOITATION OF CLAYS AND SHALES.

Mercer clay.—The Mercer clay is worked on Redbank Creek by the Climax Brick Works at Climax and by the Clarion Brick Company at St. Charles. At both places the clay is obtained by drifting. The Climax mine is 1½ miles above the plant, and is connected with it by a tram road, over which the clay is hauled in cars by horses. The St. Charles flint clay mine is about three-quarters of a mile below the plant and over 200 feet above the creek. The clay is lowered from the mouth of the mine in cars on inclined tracks, by gravity, to a tram road similar to the one at Climax. The plastic clay mine is nearly opposite the plant. The clay from this mine is brought down to the yard in carts. At both these plants the flint clay is used for making fire brick, and at Climax tuyeres also are manufactured.

At Climax three grades of clay are used. Grade No. 1 is the flint clay from which brick is made that is used in furnaces where the heat runs to 4,000 degrees Fahrenheit; No. 2 is the plastic clay used with flint clay for making tile for various purposes, which is said to be of excellent quality; No. 3 is a mixture of Nos. 1 and 2 as gathered up in the mines after the two grades have been assorted rather closely, and from this stock the second quality of brick is made. The brick is used in iron and steel works, glass furnaces, malleable-iron plants, and in any place requiring a highly refractory brick.

At St. Charles two grades of brick are produced. Both are made by the hand-mold process and dried on gas-heated floors. Gas is also used for firing the kilns. Two types are in use, the square up draft and the round down draft. The bake lasts about eight days.

Clarion clay.—The Clarion clay, the most valuable in the quadrangles, is being worked on the east side of the Allegheny River at a number of points between Kittanning and the mouth of Mahoning Creek, and on Rough Run at West Winfield.

At West Winfield the Duquesne Fireproofing Company uses the clay for making front brick, fireproofing, and sewer pipe, the latter being the principal product. The opening of drift from which the clay is taken is about 200 feet from the clay pile in the yard, and is hauled up to the latter in cars, by cable. The clay is used just as it comes from the mine. After going through the dry pan the clay for brick is put through a pug mill and stiff-mud machine, and that for sewer pipe through a wet pan and pipe press. Round down-draft kilns are used for firing. The coal which overlies the clay is used for fuel. The sewer pipe is glazed at a temperature of 2,700 degrees, but according to the statement of the superintendent the clay will stand 3,000 degrees.

On the Allegheny at Neale and at Templeton Clarion clay is at present being mined by the Harbison-Walker Refractories Company, and shipped to their plant in Pittsburg for use as a bond in making fire brick. At the former place, however, this company now has under construction a plant for the manufacture of gray front brick. The same company also operates at Cowanshannock. The clay mined at this point is used in making a low-grade fire brick and also as a bond, with flint clay brought from Brookville, for a very refractory brick. The brick are made by the usual hand-mold process, and dried on a gas-heated floor. They are baked in square down-draft kilns fired by gas.

Just north of Neale the Kittanning Clay and Fire Brick Company use the Clarion clay in the manufacture of buff and gray building brick. For gray brick the clay is used as it comes from the mine, including sandy portions and the black upper layer; for buff brick loam is added. The bricks are made by the stiff-mud process, and cut in a wire side-cut machine. About 25 per cent of them are repressed. The drying is done in tunnels heated by waste heat from the kilns. The kilns are round down-draft and are heated by gas. The bake lasts about nine days, and for gray brick a No. 9 Seger cone is turned down in the center of the kiln and a No. 3 over the fire, while for buff brick cone 01 is turned down. Both the buff and gray brick are of excellent quality, and in much demand, especially the gray, which is extensively used for office buildings in large cities.

While no Clarion clay has as yet been used at Kittanning, the Kittanning Clay Manufacturing Company is planning to reopen an old test shaft to this clay, and ultimately, if further tests prove satisfactory, it is probable that the clay will be mined.

Lower Kittanning clay.—The Lower Kittanning clay is worked at Kittanning, where it is quarried by the Kittanning Clay Manufacturing Company and by Daugherty Brothers. At the former plant the clay is used in the manufacture of buff building brick, and is also mixed with the underlying shales for front and paving brick. The stiff-mud process is employed. The kilns are fired by gas fuel and are of the square and round down-draft types. The clay is burned at about 1,200 degrees centigrade. Daugherty Brothers manufacture red and buff building brick by processes similar to those used by the Kittanning Clay Manufacturing Company.

Shales.—The shales below the Lower Kittanning clay in the quarries at Kittanning, as already stated, are used with the clay for building and paving brick. Near Cowansville the shale above the Lower Freeport coal is being quarried by the Du Bois & Butler Brick Company. This shale mixed with the clay above in the proportions in which they occur in the quarry are used in the manufacture of paving and common brick, the former being this company's specialty. In making the latter the soil above the clay is also included. The bricks are made by the ordinary stiff-mud process and burned in round down-draft kilns at a temperature of from 1,200 degrees to 1,400 degrees for common brick and 1,500 degrees to 1,800 degrees for paving brick. The fuel used is the Lower Freeport coal, which is mined below the shale.

IRON ORE.

GENERAL STATEMENT.

The production of iron from the ores of the quadrangles was formerly an important industry. A number of furnaces were erected and operated for many years, but the general use of better ores from the Lake regions and the exhaustion of the local outcrop ores made the business unprofitable and it was abandoned. The last furnace went out of blast about 1880. A brief history of these furnaces will be found in Platt's Report, H5, on Armstrong County, and in Lesley's History of Iron Making in America.

There are three ore-bearing horizons in the quadrangles, that of the Buhrstone ore at the top of the Vanport limestone, the Lower Freeport ore below the Lower Freeport coal, and the Upper Freeport ore below the Upper Freeport coal. Of the three, the first is the most and the second the least important.

BUHRSTONE ORE.

This is a compact layer running generally 6 inches to 1 foot thick, and resting immediately upon the Vanport ("Ferriferous") limestone. To this circumstance the limestone owes its descriptive name "Ferriferous." The term "Buhrstone" is due to the chert nodules said to occur in the ore in some localities. The ore may be a carbonate, limonite, or impure hematite. Probably it was originally carbonate, the limonite and hematite being the result of subsequent oxidation along the outcrop. This ore was the chief source of the iron once made in the region. It is practically coextensive with the Vanport limestone and its extent of outcrop corresponds with that of the limestone, which is shown on the map. Judging from the old strippings which follow the outcrop of the limestone for hundreds of miles, most of the ore to be had from the outcrop has already been taken out, so that in the future drifting will be necessary. As will be seen further on, this will be facilitated by the fact that the ore is generally overlain by soft shales which can be removed with comparative ease. This is not universally true, and in some localities, as near Phillipston, the ore is overlain by a coarse massive sandstone which seemingly precludes mining.

McCreath analyzed samples of the Buhrstone ore selected by Platt from all parts of Armstrong County. As a whole these analyses show not only uniformity in the grade of the ore, but also that it consists of three varieties, according to the amount of decomposition that has taken place, namely, carbonate ore, brown hematite, and an impure variety of red hematite. The unroasted carbonates average 33 to 38 per cent of metallic iron; the brown and red ores contain as high as 50 per cent of iron, the average being perhaps about 45 per cent. All of the ores are comparatively low in phosphorus—two-tenths of 1 per cent being

the usual amount, both in carbonates and hematites. The sulphur is also low, amounting in many cases to scarcely more than a trace. The hematites contain none of the protoxide of iron. The analyses are given below:

Analyses of Buhrstone ore.

RED ORE.

	Per cent.
Sesquioxide of iron	70.714
Sesquioxide of manganese	2.421
Sesquioxide of cobalt	.010
Alumina	1.491
Lime	7.630
Magnesia	.547
Sulphuric acid	.010
Phosphoric acid	.765
Carbonic acid	5.230
Water	7.465
Insoluble residue	3.860
	100.143
Metallic iron	49.500
Metallic manganese	1.686
Sulphur	.004
Phosphorus	.334

BROWN ORE.

Sesquioxide of iron	73.928
Sesquioxide of manganese	1.344
Sesquioxide of cobalt	.020
Alumina	1.532
Lime	1.610
Magnesia	.501
Sulphuric acid	Trace.
Phosphoric acid	.740
Carbonic acid	None.
Water	12.615
Insoluble residue	8.060
	100.350
Metallic iron	51.750
Metallic manganese	.936
Sulphur	Trace.
Phosphorus	.323

BLUE CARBONATE ORE.

Protoxide of iron	42.428
Sesquioxide of iron	2.233
Bisulphide of iron	.187
Protoxide of manganese	.799
Protoxide of cobalt	.010
Alumina	.916
Lime	7.150
Magnesia	1.881
Sulphuric acid	.030
Phosphoric acid	.334
Carbonic acid	32.622
Water	1.950
Insoluble residue	9.460
	100.000
Metallic iron	34.650
Metallic manganese	.619
Sulphur	.112
Phosphorus	.146

ROASTED ORES.

	Per cent.
Protoxide of iron	None.
Sesquioxide of iron	65.928
Sesquioxide of manganese	1.563
Sesquioxide of cobalt	.020
Alumina	2.688
Lime	7.710
Magnesia	.901
Sulphuric acid	.580
Phosphoric acid	1.074
Carbonic acid absorbed, Water	5.365
Insoluble residue	14.520
	100.349
Metallic iron	46.150
Metallic manganese	1.088
Sulphur	.232
Phosphorus	.469

Full details concerning furnace practice, the character and cost of the iron produced from the Buhrstone ore, and the general conditions of manufacture are contained in Platt's report,[a] to which the reader is referred for additional information.

LOWER FREEPORT ORE

According to I. C. White,[b] this ore largely supplied the old Winfield furnace. It is a mixture of carbonate and limonite, probably yielding from 35 to 50 per cent of metallic iron. Mr. Denny, on whose land the ore was mined, states that it varies in thickness from 1½ to 6 feet. This same ore was mined on the hill one-half mile north of the Butler pike in western West Franklin Township for use in Buffalo furnace and is reported 2 feet thick. It is said to have yielded about 25 per cent of metallic iron. Little is known of the extent of these deposits, but it seems likely that they are limited to small areas.

UPPER FREEPORT ORE.

The following discussion of this ore by Lesley[c] fully covers the ground:

> The Freeport (or Summit) ore, 26 feet below the coal, and running about 2 feet thick, but occasionally 4 feet (as in Phillip's hill), solid, compact, very argillaceous, almost a clay, mined by stripping; and also in gangways and rooms; mined with the pick by bearing in on the clay above and lifting the ore in masses from 15 to 20 inches thick; yielding 1½ tons to the yard, and requiring 3 to 3½ tons to the ton of metal; specked with delicate rose-colored specks throughout, from incipient decomposition; remarkably like the "Big Bottom" ore of the Connellsville and Uniontown region; disposed to make red short iron: requires mixture with siliceous ores; would be greatly improved by mixture of one-fourth magnetic or red hematite ores. * * * A vast amount of stripping and mining has been accomplished. In some spots the bed is too thin to strip; 20 feet of stripping is the maximum it will bear. Ball ore occurs under the regular bed.

The ore was mainly worked by the Bradys Bend Iron Company on the high plateau between Holder and Greenville runs. It extends also west of Holder Run apparently in workable thickness. Toward the south its horizon is under all the high land of Sugar Creek Township. North of Sugar Creek its run is obscure, probably by reason of its

[a] Second Geol. Survey Pennsylvania, Rept. H5.
[b] Second Geol. Survey Pennsylvania, Rept. Q, p. 94.
[c] Report to the Bradys Bend Company, 1865, quoted in Platt's Report H5, pp. 220-221.

diminished thickness there. A chemical analysis by McCreath of a specimen of the ore from Phillips Hill follows:

Analyses of iron ore from Phillips Hills.

	Per cent.
Protoxide of iron	38.378
Sesquioxide of iron	2.646
Bisulphide of iron	.090
Protoxide of manganese	1.153
Protoxide of cobalt	Trace.
Alumina	1.223
Lime	10.849
Magnesia	2.686
Sulphuric acid	Trace.
Phosphoric acid	.480
Carbonic acid	32.074
Water	1.910
Insoluble residue	8.540
	100.000
Metallic iron	31.750
Metallic manganese	.893
Sulphur	.042
Phosphorus	.224

COMPARISON WITH ORES FROM OTHER REGIONS.

The Lake ores average over 60 per cent of metallic iron.[a] The soft red ore and the brown ores of Alabama average over 50 per cent of metallic iron, while the hard, limy, self-fluxing red ore, the poorest ore mined in Alabama, yields on the average 37 per cent of metallic iron.[b]

As shown by the above analyses, the Upper Freeport ore of this region yields only about 30 per cent, and the carbonate, of which most of the remaining Buhrstone ore probably consists, yields only 34 per cent of metallic iron. Furthermore, on account of their thinness. mining the Allegheny Valley ores would be much more expensive than mining those with which they would have to compete. Under such conditions, therefore, the production of iron from native ores could not be profitable. Experience also shows this to be true, for within recent years unsuccessful efforts have been made in Hocking Valley, Ohio, to produce iron from the Baird ore, which is similar in character and occurrence to the Buhrstone ore, with which it is correlated.[c]

LIMESTONE.

The limestones of economic value in these quadrangles are two, the Vanport and Upper Freeport. Of these the Vanport is by far the more important.

VANPORT LIMESTONE.

As shown on the map, this has a great extent of outcrop in the region. In some comparatively small areas it is not known, and is probably absent. Where thus absent the fact is indicated on the map by continuing the line showing its outcrop as a dotted line along its probable horizon. Where present, the limestone rarely falls below 8 feet in thickness and may reach 22 feet, as at West Winfield. From an examination of the table of records of oil and gas wells (pp. 110–161) it will be seen that if the records are to be trusted the limestone runs 20 feet or more thick over an extensive area in the west and southwest parts of the Kittanning quadrangle. A thickness of 15 feet or more is recorded in many other wells in the other parts of the two quadrangles, but these records may exaggerate the thickness. This limestone is of a good degree of purity, as shown in the following analyses by McCreath:

[a] Bauerman, H., A Treatise on the Metallurgy of Iron, 1882.
[b] Phillips, W. B., Iron Making in Alabama.
[c] Orton, Edward, Geological Survey of Ohio, vol. 5.

Analyses of Vanport limestone.

	1.	2.	3.	4.	5.
Carbonate of lime	93.246	94.721	96.007	95.567	94.51
Carbonate of magnesia	1.740	1.044	1.498	1.422	....
Iron	1.667	1.383	1.462	.930	1.05
Alumina					1.80
Phosphorus	.032	.047	.034	.035	.076
Sulphur	....	....	....	....	.028
Insoluble residue	3.420	2.300	.790	2.110	....

1. From Rhea farm near Greendale, on Cowanshannock Creek (p. 97 [a]).
2. From Colwell property, Mahoning Furnace (p. 162 [a]).
3. Laughlin property, Stewardson furnace, Dee (p. 160 [a]).
4. Reynolds property, Kittanning (p. 247 [a]).
5. Sample from quarry north of Mahoning Creek, 1 mile above mouth, furnished by Henry Colwell, superintendent of Kittanning Iron Company; analyst unknown.

As a flux.—This limestone was used for flux in the old blast furnaces. At present it is so used by the Kittanning Iron Company and is pronounced by the superintendent to be very satisfactory. The supply is drawn from the quarry on Mahoning Creek mentioned above. The Vanport limestone carries too much phosphorus for making iron which is to be used in the manufacture of Bessemer steel, but not enough to injure it for mill iron and probably not enough to injure iron which is to be used for making steel by the basic process. There is nothing in its quality, therefore, to prevent it from being an excellent flux. The only obstacle to its more extensive use for that purpose is probably the fact that it would have to compete with still better and more easily obtained limestone from other localities.

For cement.—According to the above analyses, this limestone is well adapted to the manufacture of Portland cement. This is made by burning a mixture of limestone and clay or shale. About the only restriction on limestone to be used for this purpose is that the magnesia content shall not much exceed 5 per cent. The other essential ingredients of cement are silica and alumina. These are supplied by the clay or shale used in the mixture. Whatever material is used, however, the alumina should not exceed 25 per cent, as a greater proportion injures the cement. The fire clays of the quadrangles can not be used for cement making since they run over 30 per cent alumina, as shown by the analyses given in the description of the clays. At Wampum, in Lawrence County, one of the first places in this country where Portland cement was made, the materials used are the Vanport limestone and shale from an immediately overlying bed 6 feet thick. The composition of the shale is given below:

Analysis of shale near Wampum, Pa.

Silica	65.99
Alumina	21.57
Ferric oxide	6.07
Lime	.47
Magnesia	.82

It seems probable that there is in these quadrangles an abundance of shale of this character to be had in association with the limestone, and this, with the cheap supply of fuel near at hand in the Lower Kittanning coal, would seem to indicate that cement making could be made a profitable industry.

Development.—The Vanport limestone makes good lime, and is quarried at many points in the quadrangles and burned into lime by the farmers in the fields, where it is to be used as a fertilizer. This custom is facilitated by the abundant and cheap supply of coal for fuel.

At West Winfield the limestone is worked on a commercial scale by A. G. Morris. The workings consists of an open-cut quarry and two mines. The limestone at this place is 22 feet thick and in mining 18 feet are taken out and 4 feet are left for roof. It is used for railroad ballast, concrete work, artificial stone, and fluxing, and is burned into lime.

[a] These references are to Report H5 of the Second Geological Survey of Pennsylvania.

FREEPORT LIMESTONE.

This is a less persistent bed than the Vanport. It reaches its maximum thickness and greatest economic importance in the southeast corner of the Kittanning quadrangle, between Manorville and Ford City, where it is 28 feet thick.

The composition of this limestone is shown in the analyses by McCreath given below:

Analyses of Freeport limestone.

	1.	2.	3.	4.	5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Carbonate of lime	88.839	94.928	84.857	89.303	82.589
Carbonate of magnesia	1.513	1.210	1.868	1.900	5.751
Oxide of iron and alumina	2.557	1.246	2.568	2.002	3.367
Phosphorus	.021	.018	.024	.021	.063
Insoluble residue	5.030	1.920	9.520	4.830	7.310

	6.	7.	8.	9.	10.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Carbonate of lime	89.857	96.453	93.214	93.571	94.642
Carbonate of magnesia	2.898	1.445	2.065	1.324	1.574
Oxide of iron and alumina	1.860	.964	1.340	1.207	1.182
Phosphorus	.017	.007	.004	.029	.012
Insoluble residue	4.520	.830	2.220	3.170	1.850

1. From John Reefer farm, North Star ravine (Huskins Run?) (p. 93[a]).
2. From William Marshall property, Dayton (p. 141[a]). This locality is east of the Rural Valley quadrangle.
3. From William Hamilton property near Putneyville (p. 154[a]).
4. From property of A. J. Dull & Co., Manorville, layer No. 1 (p. 257[a]).
5. From property of A. J. Dull & Co., Manorville; layer No. 9 (p. 257[a]).
6. From property of A. J. Dull & Co., Manorville; layer No. 11 (p. 257[a]).
7. From Mehaffey's quarry, Logansport, just south of quadrangles; bank No. 1 (p. 257[a]).
8. From same quarry, bench No. ? (p. 257[a])
9. From same quarry, bench No. 11 (p. 257[a])
10. From Monroe property on Buffalo Creek south of quadrangles (p. 289[a]).

These analyses show considerable variation in the composition of the limestone. It generally carries less phosphorus than the Vanport. On the other hand they show in some cases, as at Manorville, a smaller percentage of carbonate of lime and much more insoluble matter, the decrease in the former being made up by the latter, which probably is mostly silica. At Mehaffey's quarry at Logansport, however, the percentage of carbonate is about the same as in the Vanport, while the phosphorus is very low. It would seem from these facts that the limestone at Manorville would not be suitable for flux, but would answer very well for making cement. It might be found that the clay and shale interbedded with the limestone, as shown in the section just referred to, would be suitable for mixing with the limestone in cement making, so that the whole stratum could be mined out and utilized. The limestone from this locality was once extensively quarried and shipped to Pittsburg for use as flux. The discontinuance of this industry was doubtless due to the fact that the limestone could not compete in the market with that of a better grade from other regions. Both the Vanport and Freeport limestones would afford a supply of road metal, probably, of good quality.

GANISTER.

A hard sand rock is used by the Cowanshannock brick works to mix with lime for making silica bricks. The exact source of this material is not known to the writer, but it is possibly the Clarion sandstone, which is of a coarse quartzose character along Cowanshannock Creek from its mouth to the old mill 1 mile above.

[a] These references are to Report H5 of the Second Geological Survey of Pennsylvania.

BUILDING STONE.

On the hills southwest of West Winfield the Saltsburg sandstone is extensively quarried by the Conemaugh Stone Company of Cresson, Pa. This sandstone practically forms the surface of the flat hilltops and can be reached by a minimum amount of stripping. The quarry already extends over a large space, throughout which the rock varies in thickness from 10 to 15 feet. The rock is a coarse-grained, free-working sandstone, in layers of such thickness that it is easily quarried and made into dimension stone of convenient size. It is suitable for coarse masonry only and is used for railroad purposes. The quarried blocks are let down by an incline to the West Winfield Railroad for shipment. On the east bank of Allegheny River, about three-fourths mile south of the mouth of Cowanshannock Creek, what is probably the Clarion sandstone has been quarried to a considerable extent for the same purpose, as has also the Freeport sandstone in the west bluff of the river just south of Applewold. There is a great abundance of sandstone to be had for coarse masonry throughout both quadrangles and further discussion is not demanded here.

SAND.

At West Winfield the Saltsburg and Clarion sandstones are being ground into sand. In the vicinity of Kittanning large quantities of sand are dredged from the river and used for grinding plate glass at the Kittanning plate glass works. It is also used to a less extent for mortar. It is prepared for use by being passed through three screens and then thoroughly washed. On the west side of the river opposite Ford City the Mahoning sandstone is extensively quarried by the Pittsburg Plate Glass Company, and reduced to sand, which is used for grinding glass at Ford City.

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CLASSIFICATION OF THE PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Bulletin No. 279.]

The serial publications of the United States Geological Survey consist of (1) Annual Reports, (2) Monographs, (3) Professional Papers, (4) Bulletins, (5) Mineral Resources, (6) Water-Supply and Irrigation Papers, (7) Topographic Atlas of United States—folios and separate sheets thereof, (8) Geologic Atlas of the United States—folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists can be had on application.

Most of the above publications can be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they can be obtained, free of charge (except classes 2, 7, and 8), on application.

2. A certain number are delivered to Senators and Representatives in Congress for distribution.

3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they can be had at practically cost.

4. Copies of all Government publications are furnished to the principal public libraries in the large cities thruout the United States, where they can be consulted by those interested.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports. This paper is the sixty-seventh in Series A and the eighty-third in Series B, the complete lists of which follow (PP=Professional Paper; B=Bulletin; WS=Water-Supply Paper):

SERIES A, ECONOMIC GEOLOGY.

B 21. Lignites of Great Sioux Reservation: Report on region between Grand and Moreau rivers, Dakota, by Bailey Willis. 1885. 16 pp., 5 pls. (Out of stock.)

B 46. Nature and origin of deposits of phosphate of lime, by R. A. F. Penrose, jr., with introduction by N. S. Shaler. 1888. 143 pp. (Out of stock.)

B 65. Stratigraphy of the bituminous coal field of Pennsylvania, Ohio, and West Virginia, by I. C. White. 1891. 212 pp., 11 pls. (Out of stock.)

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B 132. The disseminated lead ores of southeastern Missouri, by Arthur Winslow. 1896. 31 pp. (Out of stock.)

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B 139. Geology of Castle Mountain mining district, Montana, by W. H. Weed and L. V. Pirsson. 1896. 164 pp., 17 pls.

B 143. Bibliography of clays and the ceramic arts, by J. C. Branner. 1896. 114 pp.

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PP 10. Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska, by way of Dall, Kanuti, Allen, and Kowak rivers, by W. C. Mendenhall. 1902. 68 pp., 10 pls.
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B 212. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes and William Kennedy. 1903. 174 pp., 11 pls. (Out of stock.)
B 213. Contributions to economic geology, 1902; S. F. Emmons and C. W. Hayes, geologists in charge. 1903. 449 pp. (Out of stock.)
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